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ENTOMOLOGICAL RESEARCH

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FOREWORD.

Scientific opinion in this country has for some time been alive to the necessity of placing Entomological research in our tropical possessions in Africa on a proper basis, and, the matter having been brought to the notice of the Secretary of State for the Colonies, his Lordship decided to call an informal meeting of certain Zoologists interested in Economic Entomology.

The meeting was held on the 26th March, 1909, and the following gentlemen attended :—

The Earl of Crewe, K.G.
Lieut.-Col. A. Alcock, C.I.E., F.R.S.
Mr. R. L. Antrobus, C.B.
Dr. G. H. Carpenter.
Dr. S. F. Harmer, F.R.S.
Dr. Gordon Hewitt.
Sir Francis Hopwood, G.C.M.G., K.C.B.
Mr. F. P. Jepson
Mr. C. G. Lamb.
Mr. Guy A. K. Marshall.
Mr. R. Newstead.
Prof. G. H. F. Nuttall, F.R.S.
Mr. H. J. Read, C.M.G.
Hon. N. Charles Rothschild.
Dr. D. Sharp, F.R.S.
Mr. R. Shelford.
Dr. A. E. Shipley, F.R.S.
Mr. F. V. Theobald.
Mr. C. Warburton.

All present offered their most cordial cooperation, and as a result of the discussion, the present Committee was appointed by the Colonial Office, for the purpose of furthering the objects in view.

The Committee was fortunate enough to secure as Chairman, Lord Cromer, who has since then taken an active and most helpful part in their deliberations.

I do not think I can do better in trying to outline the scope of the work which the Committee hopes to undertake than to quote—not without a few alterations—a minute I drew up for Lord Crewe on the 18th January, 1909.

> "Within the last few years there has been a very remarkable increase in our knowledge of the rôle played by insects in relation to all sides of human activity, and especially in our knowledge of the part played by both insects and arachnids in conveying diseases caused by animal (Protozoa and Helminthes) and vegetable (Bacteria) parasites both to man and to domesticated animals. The relation of insects to the crops on which man is ultimately dependent for food is also a matter demanding immediate attention.

"The importance of insects and ticks in relation to the spread of disease in man and animals is now widely recognised. The malaria parasite is conveyed to man by Anopheline mosquitoes, that of yellow fever by *Stegomyia fasciata*, likewise a species of mosquito. Plague in man and animals is in most instances conveyed by fleas. The Trypanosomes which cause sleeping sickness in man, and nagana in horses, cattle and other animals, are conveyed from host to host by flies belonging to the genus *Glossina*. African relapsing fever in man, a fatal disease in poultry, redwater and East Coast fever in cattle, malignant jaundice in dogs, biliary fever in horses, and heartwater in sheep and goats, are all important diseases which are transmitted by different species of ticks.

"Further, apart from disease in man and his cattle, there is the widest field, at present almost unworked in Central Africa, for investigation into the life-histories and habits of the numerous insects which prey upon, and not infrequently annihilate, the crops upon which humanity is largely dependent for its daily food. The success or failure of the colonisation by white people of such a country as Uganda will almost certainly be profoundly influenced by the insect enemies of their crops, and it is of the highest importance that the necessary machinery for dealing with these enemies should be in working order, or great loss and profound disappointment in the resources of the country will ensue. The names of the insect pests are too numerous and too well known to need mentioning, but it is worthy of remark that, while a sound and efficient series of investigations has been established in South Africa and in Egypt, similar enquiries in Central Africa, the northern and southern portions of which are already being colonised, have yet to be made.

"It is not too much to say that the cause of the almost complete closure of Africa—lying as it does at the very foot of Europe—until quite recent times, with the exception of a narrow littoral fringe, has been the existence of disease- and death-carrying insects and ticks.

"On the other hand, it must not be forgotten that many insects are beneficial to man. More than one kind of ladybird, belonging to the genera *Vedalia* and *Orcus*, introduced from Australia, has done much to free the Californian orange trees from that destructive pest, the fluted scale, *Icerya purchasi*, and Dr. Sharp states:—'If anything were to exterminate the enemies of Hemiptera, we ourselves should probably be starved in the course of a few months.' If possible, it is important to find out what insects are helpful to man in any new country before the advent of large numbers of colonists upsets, as it is bound to do, the balance of power in the animal world.

"It would thus seem most urgent, if we are to make our Central African Colonies habitable and profitable, and, in a degree, healthy, for

white men, that increased attention should be paid to the insect fauna whether it be inimical or helpful to man ; and since the inimical insects play the larger part in the problem, it is suggested that a beginning should be made with them.

"The work falls naturally under two heads : (*a*) work in the Colonies, on the spot, (*b*) work that can be done in England.

(*a*) With regard to the work in the Colonies : we could hardly have too many collectors, but, as a beginning, a start might be made by two trained naturalists. Their duties would be threefold :—

(i) To form collections of all sorts of insects and ticks, but, at any rate at first, especially of those which come in direct relation to man, to domesticated cattle, and to cultivated crops.

(ii) To observe and note as completely as possible the life-histories, habits and habitats of the insects or ticks collected.

(iii) To interest the resident officials in entomology ; to induce them also to collect, and to teach them how to "set" or preserve the insects and ticks for transportation to England.

"Of these duties the second is by far the most important, it can only be done on the spot, and it alone points the way along which remedial measures—if such be required—must be followed.

"The Entomological Collection at Lagos and other centres should be developed. As each insect is determined, a named specimen should be sent to this Collection, and should the number of specimens allow, to each of the Schools of Tropical Medicine in Great Britain.

"The Government of each Colony should supply, within reasonable limits, its officials with the necessary apparatus for making the entomological collections.

(*b*) The collectors in the Colonies cannot be expected to determine accurately the specific names of the specimens they collect. They have neither the necessary books of reference at their disposal nor the types or cotypes of the great museums at hand. It is in this respect that the cooperation of workers in England is urgently needed ; and since the number of species of insects is so prodigious, it will be necessary to have recourse to several specialists, each of whom might be asked to deal with one Order, or better, with one family, or, it may be, with a single genus. Even if the collectors ignore—because, according to our present knowledge, they exert but little influence on human affairs—such orders as the Lepidoptera, the Neuroptera, etc., we are still left with such a mass of unworked material that it would be beyond the powers of any group of workers in England to sort out and

determine accurately all the species within a reasonable time. Hence, it would seem wise at first to confine attention to such insects and ticks that bite or 'sting' man or his domesticated animals with their mouth-parts, or are parasites of man and domesticated animals; also to such as may be responsible in other ways for the dissemination of disease, and to those which are at present, and patently, destroying crops and timber.

"There would further be necessary a publication in which the results of the work done could be rendered accessible to those at work and to the public.

"Finally, I should like to add that, in my opinion, a similar scheme for investigating the vermian and protozoan parasites of man and domesticated animals in the same Colonies is urgently to be desired."

The object of the Committee, as outlined above, is to procure the fullest possible knowledge of the Insects of tropical and subtropical Africa. Arrangements have, however, been made through the Colonial Office by which the Committee will be kept in touch with the organisations that already exist; both to the north, with the authorities of the Sudan and of Egypt, and to the south, with the Entomologists of Rhodesia and the united South African States.

The need for such an organisation is obvious. According to the calculations of Dr. Günther, in the year 1830 the number of insects described and named, and in many cases figured, was 49,100, or let us call it 50,000: in the year 1881 the number increased almost to 220,150, or let us call it 220,000.

Taking an average year (1897) between 1881 and the present date, but rather nearer the latter because yearly the number of newly described species become larger, Dr. Sharp tells us that according to the *Zoological Record* the number of insects described in this year was 8,364. If we multiply this number by twenty-seven, the number of years which have elapsed since Dr. Günther made his estimate, we find a total of 225,828 (call it in round numbers 225,000) insects described and named in the last twenty-seven years. If we add to this the number of insects estimated by Dr. Günther in 1881, we reach a total of 447,978, in round numbers nearly 450,000 known and named insects. Calculations, dealing with the whole number of animals of all sorts described or figured and not with Insects alone, show that there are at present some 600,000 described species of living animals, and it becomes apparent that of this large total about three-fourths belong to the Group Insecta.

The estimated number of described Insects, large as it seems, is however but small in comparison with the number of species collected and deposited in Museums where no one has time to work them out. It is still

smaller in comparison with the vast numbers of species as yet uncaptured. Dr. Sharp in 1895 calculated that there were a quarter of a million known and described insects, this was an increase of 30,000 over Günther's figures of fifteen years before, but he states that in his opinion this quarter of a million is but one-tenth of those which exist.

Without attaching too much importance to the accuracy of these calculations, it is evident that the amount of material which is at the disposal of the Entomologists of the world is almost overwhelming, and at present the workers at all the Museums in the world are not able to cope with it.

Thus, when it seemed possible to do something to work out the Insects of tropical and subtropical Africa, it became necessary to attempt to establish some new organisation, and in this view the Committee were strengthened by the consideration that, if the insects collected were incorporated in the great National Collections, they would quite rightly be arranged in their proper systematic position and not kept apart as African, in which case they would gain in their attributes of affinity but lose in their character as African.

It thus seemed wise to establish a separate organisation which would undertake to collect and name the collections; but the work of the Committee will be in no way confined to this. It is, as outlined above, intended to send out two competent entomologists, one to Eastern and the other to Western Tropical Africa, and the Committee has been fortunate in securing the services of two well-known and experienced entomologists, Mr. S. A. Neave and Mr. J. J. Simpson. By the time these lines are in print these gentlemen will have already left England, the former having gone to Nyasaland, the latter to Nigeria. These gentlemen will not only collect but will endeavour to interest and instruct such residents in Africa as may feel an interest in Entomology. Observations on the bionomics of Insects and Ticks, the noxious or beneficent action of their methods of feeding, the course their life-history follows, are all obviously matters of the very highest importance; and these observations can only, as a rule, be completely followed out by those who can observe all the year round, during spring, summer, autumn and winter. Although such enquiries may be stimulated and initiated by the Entomologists who are being sent out, they must necessarily be travelling about, and it is to the resident that we must look in the main for working out life-histories.

The chief Protozoan diseases conveyed from one animal to another are, as is said above, carried by Insects and Ticks. I have for a long time sought for some feature common to the IXODIDÆ and the INSECTA, and to these groups alone, which would help one to coin a word that would denote insects and ticks, and them alone. I have so far not succeeded. Of course both are Arthropods, but the term Arthropods includes an innumerable variety and a vast mass of living matter. Probably seven-eighths of the living protoplasm at the present time on the surface of the world is wrapped up in the

body of Arthropods, but it would shorten our treatises if some ingenious person would suggest a word which would denote Insects and the Ticks, and no other group of animals.

One other matter it seems to me the Committee might well deal with, and that is the question of the common or vulgar names of Insects. The English language, far more than some others, is wanting in names to express the common insects, and one name is frequently used to include animals that are widely different. For instance, the term "Wireworm" is applied to the Myriapod *Julus* and to the larvæ of certain beetles of the family ELATERIDÆ. The American Association of Economic Entomologists have recently issued a long list of common names of Insects with their corresponding scientific names appended, and they intend, as far as lies in their power, to insist that the common name suggested should be used for this and for no other species. It would be a useful function if the African Committee would draw up a list of common names of African Insects, giving in all cases their scientific equivalents, and insist that these and no other names be used.

ARTHUR E. SHIPLEY.

ON THE LARVAL AND PUPAL STAGES OF WEST AFRICAN CULICIDÆ.

By W. WESCHÉ, F.R.M.S.

With Field-Notes by the Collector, Dr. W. M. Graham.

(Plates I. VII.)

In dealing with this extremely interesting and valuable collection of Mosquito larvæ and pupæ from Lagos, which we owe to the industry of that indefatigable collector and observer, Dr. W. M. Graham, I have endeavoured to give a practical and not too technical description of each species, and I have given illustrations of all the principal characters, and of some points of more general interest. If technicalities are indulged in, they are explained in the preliminary text, and in the plates. It has been my object to make it impossible for the careful worker to mistake any one of these larvæ for that of another species, but persons who have experience of such work, know the difficulty of arriving at such results without a knowledge of all known forms, and that knowledge I have no pretensions to possess.

In my keys I have taken the most simple and obvious characters as guides, and I may point out for the information of those who approach the subject as novices, that with a little experience it ought to be easy to recognise the two most dangerous groups of mosquitoes in their larval stages: the Anophelines by the absence of the respiratory tube or siphon, and the presence of long feathered plumes on the thorax; and the *Stegomyiæ* by the short stumpy siphon, often with serrated spines, and the numerous star-like, or stellate, hairs scattered all over the body (Pl. III, figs. 3 & 7); while larger heads and longer stout siphons suggest, if the spines are serrated (Pl. II, fig. 10), a relationship to the genus *Aëdes*; and the very long thin siphons have been recognised as sometimes belonging to the restricted genus *Culex*. The paper is arranged in the following order:—

1. Technique, including measurements and the examination of living larvæ.
2. Characters of the larvæ and pupæ.
3. Keys to the species described, larvæ and pupæ.
4. Separate description of each species.
5. Plates and explanation.

Technique of Examination.

The larvæ and pupæ were preserved in tubes of formalin ; it was desirable that they should be examined in the medium they had been in, so they were taken out of the tubes by a small lifter * and transferred to a shallow glass trough, half full of formalin : this was placed on the stage (flat) of the compound microscope, and the larvæ examined with a magnification of about 60 diameters. In those with very long siphons, and in all the pupæ, some difficulty will be met with in getting dorsal views, and even more difficulty in getting ventral views. In the larvæ, when material is abundant, this is got over by detaching the head, or the siphon. In cases where it is not desirable to damage the specimens, and with the pupæ, the difficulty can be got over by using a rectangular trough with sides about 2 mm. deep, when the head or the upright siphon can be placed in the angles †.

In manipulation it is well to use a bristle in a handle, or, better still, the finest entomological pin with the head off, and fixed in a handle till only 4 mm. remains visible ; the point must be pared down (on a glass slip is best) with a penknife, till only a fine strip of metal remains, and the last half millimetre is slightly bent.

A dorsal examination gives the best view of the antennæ and of the facial plumes and eyes, but the ventral side shows the mouth better. To understand the mouth structures properly, they must be carefully dissected and teased apart ; the fragments cleared in phenol and xylol, spread on a glass slip, and mounted in balsam.

The thorax and abdomen must be looked at from both sides. The weight of the siphon will, except in the case of the Anopheline larvæ, or in those with very short siphons, turn the last two segments of the abdomen partially round, so that a lateral view, or semi-lateral view, is obtained of the seventh segment. If there is any difficulty, wedge the head in a corner.

The siphon, comb and anal segment are best seen laterally, except in the case of very dark larvæ ; the pupæ are also to be examined in this way : but when the anal plates are looked at, a dorsal or ventral view is necessary, and then the creature has the last three segments broken off, or is placed on its back with its head in a corner, or is hung on a bent pin, as suggested in the note below.

Measurements and Comparisons.

These are best made with a numbered scale dropped in the eyepiece of the microscope, when the units can be read off and compared.

* A strip of zinc 2 mm. broad, and of suitable length, fixed in a handle, answers well.

† A much bent mosquito pin (silver and as thin as possible) shaped so that it forms a cradle or a little elevation, can be placed in the trough, and the larvæ and pupæ arranged on it, so as to give particular angles ; this has been found very useful.

1. The abdomen will be measured from the base of the thorax to the end of the eighth segment ; the anal segment being excluded.

2. The siphon, from the chitinous ring at the base to the tip ; the valves being excluded, and the breadth being that of the chitinous ring.

3. The measurements of the anal segment will be the greatest length and breadth of the chitinous plate of which it is formed.

4. To measure the whole larva or pupa, the trough is placed on a metric scale of metal or ivory ; the contained creatures are then arranged on the scale, and the measurements read off with a lens magnifying 12 to 15 diameters. In the case of the pupa the only measurement used is the greatest length of the thorax, as the tail varies so much in its curves and positions that no useful comparisons can be made.

Examination of Living Larvæ.

For this purpose a well made Rousselet live-box, or a compressorium, is necessary ; the larvæ are transferred with a pipette, and with a little practice it will be found that they can be kept quiet without injury, and can after examination be returned to an aquarium or other breeding arrangement.

Characters of various Parts.

The Hairs.

The hairs of aquatic larvæ constitute one of their most striking features, and those of the Culicidæ present an extraordinary variety, often affording very beautiful objects for the higher powers of the microscope. For the purposes of determination and comparison, a certain amount of exactness in definition will be found of use. I therefore propose the following :—

1. A *hair* is elastic, may be long or short, exceedingly thin or moderately stout.
2. A *bristle* is not elastic, never very short ; it is stouter than a hair, and may be curved, sharp or blunt, or even thickened at its end.
3. A *spine* is of any length, it is otherwise a thick bristle which is straight and sharply pointed.

Hairs may be further subdivided, and I follow the classification of these structures suggested by Nuttall and Shipley.

a. *Feathered hairs.*—This term is used when the secondary hairs are all in one plane and are very long, as in the thoracic plumes of the Anophelinæ (Pl. VI, fig. 3).

b. *Plumose hairs* are those in which the secondary hairs are shorter and are, or are not, in the same plane : such as the antennal plume in most larvæ (Pl. I, fig. 1).

c. *Subplumose hairs.*—Refers to those in which notches can be seen with a magnification of 60 diameters, but having only very short secondary hairs. A rare condition. (Pl. III, fig. 17.)

d. *Branched hairs.*—Applied to hairs which bifurcate into one or more branches, such as the end hairs of some antennæ (Pl. V, fig. 3).

e. *Simple hairs.*—Signifies that the hair is without secondary structure.

f. *Plumes* may all spring from a number of sockets or be the outgrowths of a single hair—consequently their bases may or may not be in the same plane. The hairs may be simple, plumose or feathered.

g. *Tufts* are short, and the hairs are never in the same plane at the base (Pl. VII, fig. 9).

h. *Palmate hairs* consist of a fan-like arrangement of flat spines, springing from a single basal hair, and are found in various stages of development on the larvæ of the ANOPHELINÆ (Pl. V, fig. 22).

i. *Stellate hairs* are simple hairs, usually not less than three, or more than five, springing from a single base (Pl. VII, fig. 3).

THE HEAD.

The size and shape of this part present many variations; the chitin is also often different, some heads being transparent and others semi-opaque, or even opaque.

THE ANTENNÆ.

The colour is variable, and minute spines are present on the surface in varying degrees. A plume may or may not be present, and may consist of simple or plumose hairs; it may be inserted at varying distances along the shaft and the antennæ may be constricted at the insertion. The distal joint is usually shorter than the basal; it bears spines at its end which vary in colour and length, and a small number of hairs which may be simple or branched.

THE MOUTH-PARTS.

Judging from the nomenclature adopted by Theobald, Nuttall and Shipley, Giles, Felt and Mitchell, little or nothing has been done on this subject since Meinert published his paper in 1886 *. I arrive at this conclusion because in several of my preparations I find at least three structures that are not mentioned by any of these writers. Nuttall and Shipley say †: "There is nothing which can be homologised with the second pair" (of maxillæ); though this statement was made only in regard to *Anopheles maculipennis*, Mg. In an undetermined Culicine larva from Ceylon in my collection, there is, under the small piece between the brushes, which I call the labrum, an organ of some complexity, which I also find in one of these larvæ, *Culex dissimilis*, Theo. (Pl. IV, fig. 6). But in this species and in *Culex caliginosus*, Graham, are homologous organs of great complexity, which appear to represent the labium. This is found immediately under the "under lip" of Meinert, that serrated chitinous shield that forms so prominent a part of the ventral side of

* Dan. Selsk. Skr. III. Die eucephale Mygelarver. Copenhagen, 1886.

† "The Structure and Biology of *Anopheles maculipennis*." Jour. of Hygiene, Jan. 1901, p. 55.

the head. At its back are muscular and glandular (?) structures, and passing into it is the pharynx; the part itself is formed of a number of minute chitinous structures. I shall content myself with figuring this part as I have found it in one species (Pl. IV, fig. 2), reserving for a future paper the discussion as to its homologies; yet I will say that I doubt the accuracy of Meinert's determinations of the other parts, but as his nomenclature has been adopted in all the best known works on the subject, I have no option but to follow it in the descriptions in this paper; for to do otherwise, would only hamper its utility and practical application.

The Brushes.

These are two chitinous processes studded with a multitude of sockets, in which are inserted hairs which vary, in the different species, in degrees of thickness and complexity. They are moved by the four largest muscles in the head, and are often the most prominent part of it (Pl. IV, figs. 8, 9, 19).

In most cases the individual hairs are simple, but in two of the larvæ examined very remarkable developments were found. Those in *Culex caliginosus*, Graham, are very beautiful microscopic objects, each hair having at its end a minute comb.

In *Culex tigripes*, var. *fusca*, Theo., the hairs are much fewer and stouter, and each hair is regularly pectinated for a great portion of its length (Pl. III fig. 15).

Nuttall and Shipley have beautifully described the manner in which the brushes are used in *Anopheles maculipennis* to sweep the water (*l. c.* p. 56); but the *maculipennis* hairs are simple, and it seems probable that even the most minute living organism would fail to elude these more modified and complicated brushes.

The Labrum.

Looking down on the front of the head a plate is seen, often with two curved short bristles at its sides; this is the clypeus. In the middle, between the brushes and below the clypeus, is a semi-circular plate with a rather roughened edge. When this is dissected out, or a preparation is made permitting of its examination with high powers, it is found to cover an organ of some complication (Pl. IV, fig. 7). The central portion consists of two spines on an oblong base, which is behind a shorter piece of somewhat similar form; this is flanked on either side by a spine and a tuft of hair. It is a little more than $\frac{1}{10}$ mm. in breadth (Pl. IV, fig. 6). I find it in a Sinhalese larva, and also in the African *Culex dissimilis*, Theo.

The Mandibles.

These are far more highly complicated than is usual in insects. The two I have dissected out, namely, those of *Culex caliginosus*, Graham, and *C. dissimilis*, Theo., are easily homologised, part for part, with Nuttall and

Shipley's figure 11 of Plate ii (*l. c.*), and bear the two stiff bristles which, as they observed, were used to clear the brushes. When the head is looked at from the ventral side, the chitinised teeth can be seen in the interior of the mouth, under the maxillæ and just above the under lip (Pl. II, fig. 10; Pl. IV, fig. 5).

The Maxillæ.

These occupy a very prominent position when the mouth is looked at from the under side, and are very diverse and characteristic in appearance. In *Anopheles* well developed palpi are present, but in other forms these organs are much atrophied, and in *Culex caliginosus*, Graham, I think they are completely aborted. The maxillæ in this species are small, hairy and palpiform in appearance. In *C. dissimilis*, Theo., they are less palpiform, and have a strong brush at the apex, besides rows of spines; palpi are present, but in an atrophied condition. In this species the maxillæ have several short claws at the end (Pl. IV, fig. 4), and I have also seen these on *Pectinopalpus fusca*, Theo., ♀ (I) as very insignificant appendages to the long maxillæ.

The Labium.

This organ may be represented by the complicated structures found in the heads of *Culex caliginosus*, Graham, and *C. dissimilis*, Theo.

It presents a very different appearance in the two species. In the former there is a central brush of spines from which proceed paired rods which curve outwards: in the spaces between the spines and the rods are two pairs of stout blunt hairs, which do not differ in appearance from the "taste hairs" on the mouths of insects: the parts are flanked by complicated toothed plates, and have above them two longer stout blunt hairs, and a pair of minute two-ended processes. The whole is very small, as at its greatest width it is but $\frac{1}{75}$ mm.

In *Culex dissimilis*, Theo., the organ is dissimilar in appearance, though of about the same size. In the centre is a three-pointed process, on either side of it being the four "taste hairs," and it is flanked by toothed processes; from the central process proceeds a short rod, which extends to an opening of a hexagonal shape in a plate of complicated folds: at the top is a curved plate with spines at its outer ends (Pl. IV, fig. 2). From the middle of these organs runs down the pharynx, a transparent membranous tube.

Near this part in *C. dissimilis* is a pair of circles with transparent cilia (Pl. V, fig. 1), which are identical in structure with similar circles or ovals found in the same portion of the head of some Isopods—such as our common wood-louse (*Porcellus scaber*)*.

* Miall, 'Aquatic Insects,' p. 117, notices this organ in *Corethra* and *Culex* larvæ.

The Lower Lip.

This part is very similar in both Anopheline and Culicine larvæ, being a striking, much chitinised, serrated shield, which lies in the median line of the under side of the head (Pl. IV, fig. 3).

The Face.

This part, the dorsal front of the head, varies in size and character, as well as in the number of the plumes; pigment-spots are often present, especially two half-moons near the bases of the brushes.

There are usually six plumes on the fore part of the head, each having from three to eight hairs; and behind these are four minute stellate hairs, flanked by two longer plumes (Pl. II, fig. 11).

The Eyes.

The eyes are variable in shape; in some stages of the Anophelines examined they were reduced to small round bodies, but in others they are of a sub-lozenge or half-moon shape, and have often a small pigmented mass of eye-structure behind. As, however, the eyes appear to undergo great changes in the larval moults, these characters are unreliable, and it is best to record only the condition of the mature forms.

The Thorax.

The relative size of this part undergoes many changes, particularly in the Anopheline larvæ, but the plumes on it are fairly constant. It must be examined on both sides; the dorsal anterior edge has many plumose hairs which often reach forward, quite over the head, and there are two pairs of plumes behind these and two on the shoulders (Pl. II, fig. 11).

The majority of the plumes are on the ventral side, and three or four hairs usually spring from a chitinous tubercle. All these plumes in some measure accentuate the three segments of the thorax (Pl. II, fig. 10).

In the mature larvæ of *Pyretophorus costalis*, Lw., there is a regular and geometric pattern on the ventral side, and this character appears confined to the mature larval stage (Pl. VI, fig. 1).

The Abdomen.

The abdomen consists of nine segments of which the first two bear plumes, usually of a similar character to those on the thorax. The dorsum is studded with innumerable combinations of small and large stellate and other hairs, but except when the part is unusually hairy, as in *Stegomyia africana*, Theo. (Pl. III, fig. 7), the characters are rarely specific. The eighth segment is, however, a striking exception, as it bears on each side a patch of spines known as the comb and on the dorsum the highly important siphon or respiratory tube; the ninth or anal segment is also of great use on account of its appendages. On the posterior side of the siphon, and usually on the membrane between the eighth and anal segments, are two plumes, usually

socketed on short tubercles; these I call the *sub-siphonal* plumes; the lateral plumes at the base of the siphon itself I call the *siphonal* plumes (Pl. I, fig. 4). There is often a third plume (laterally) at the base of the anal segment, and this is generally of simple hairs, it being exceptional to find that condition in the other two.

The Comb.

This consists of a number of spines or scales on each side of the eighth segment, which present remarkable specific characters * when they can be seen; but the difference in their appearance, brought about by the angle from which they are viewed, is so great that, in discriminating species, it would be dangerous to rely upon this character alone. The combs are best seen on the lighter-coloured larvæ, and from a lateral view, with the siphon lying as flat as possible in the trough; if they cannot be made out then, as sometimes happens, a dorsal view will partially show them. To secure this, the siphon must be perpendicular, often out of the liquid: as I have already explained, this is managed by placing the head in a corner of the trough.

The combs on the Anopheline larvæ are on the lateral supports of the platform on which the spiracles open.

When mounted in balsam the combs are rendered so transparent that they are exceedingly difficult to see with the best of objectives and substage illumination, and in this condition I find it almost impossible to count the scales with any degree of accuracy. As I propose to describe only what I can see with 60 diameters, I shall not rely on the combs more than I can help for specific characters. The difficulty of using these structures for such a purpose is illustrated by my personal experience. I possess a beautiful preparation of the larva of our British *Ædes cinereus*, Mg., in formalin, made and given to me by Mr. H. J. Waddington, F.L.S., of Bournemouth. Though I am able to use a very good $\frac{1}{7}$ on the comb, I cannot satisfactorily count the scales or be sure of their real shape either with a high or a low power objective.

I also drew some of the scales of the comb of *Stegomyia fasciata*, F., and of *S. africana*, Theo., from larvæ lying in the trough of formalin, using a $\frac{3}{4}$ objective, and I could not separate these two species on what I saw, as my drawings were practically the same. I suspect that with a little imagination I could see on *S. africana*, Theo., the elaborate structures that are figured, as existing in *S. fasciata*, in Goeldi's 'Os Mosquitos no Para' (Brazil, 1906, Plate F). Indeed at the present moment I am by no means sure that they do not exist, nor can I be certain without making careful stained preparations, capable of being examined with higher powers than those employed.

The Siphon.

This part varies so much and has so many subsidiary hairs and spines that

* Since the above was written I have been able to examine a greater number of preparations; I am now inclined to think that they are more of generic than specific importance.—W. W.

it is perhaps the most important character in the larva. The species contained in the present collection exhibit a great variety in the form of this organ, which is extraordinarily developed in some of them. In the Anopheline larvæ it can scarcely be said to be present, but the homology of the parts is at once evident, if one of the stouter siphons, such as that of *Culex tigripes* (Pl. III, fig. 14), is arranged so as to enable the observer to look directly down on the spiracles (Pl. V, fig. 19), when a similar arrangement to that which exists in the Anophelines will be seen.

The siphon, be it long or short, contains the spiracles of the two trunks of tracheæ that run down the dorsum of the larva : at the ends of these tracheæ are flaps or valves, which apparently may serve different purposes. In some cases they appear to be pulled down by muscles so as to close, or rather plug, the mouth of the siphon ; while in *Culex tigripes* the presence of certain sclerites, which have the appearance of apodemes, suggests that they flap over the openings of the spiracles. I find in the larvæ of *Phorocera serriventris*, Rondani (=*P. concinnata*, Mg.) such apodemes at the anal spiracles, and they are constantly present in the imagines of all Diptera, so that when they are seen, one may infer, with great probability of correctness, that they are used to open and close the breathing apparatus.

The siphon has a highly chitinised ring at its base, which is useful for comparative measurements, and often, on the ventral side, a median ridge on which are sometimes inserted plumes or hairs ; in other cases double rows of plumes are found, one on each side of the median line.

On either side, usually beginning at the base, and on the ventral side are two rows of spines ; judging from a rather obscure description by Felt *, these are his "*pectens*." I shall mention them as spines, or siphonal spines ; they form a very important character in their various arrangements, and in some cases their shapes. Besides these spines, there are often present stellate and other hairs that afford specific characters.

The Anal Segment.

This is the ninth segment of the abdomen, and makes the thirteenth of the whole larva, the number usually found in Nematocerous forms. The part has four appendages at its end which are called the papillæ, and are of various lengths, shapes and colours ; and in at least one species, two of them are quite chitinous (*Culiciomyia cinerea*, Theo.). On the dorsal edges of the segment are long hairs and plumes, and on the ventral side a number of plumes, which may be quite at the end, or fringe the side ; this I call the ventral beard. It is curious that however plumose the hairs may be on the thorax and rest of the abdomen, the hairs on this segment, like the plume at its base, are usually simple (Pl. I, fig. 4). In one species, *Culex tigripes* var. *fusca*, Theo., which presents a number of peculiarities in the mouth and siphon, the surface of this segment is quite rough (Pl. III, fig. 12).

* New York State Ed. Dep., 20th Report of the State Entomologist—Bull. 97 : Entom. 24, pp. 445–9.

THE PUPÆ.

These are comparatively simple, and consequently difficult to differentiate, but characters will be found in the respiratory trumpets and in the short plumes and bunches of hair at the base of the thorax ; there are also small plumes on the points of the seventh segment of the abdomen. This segment also supports two plates (the anal plates), which vary in shape, in the character of the thickening ribs, in the short bristles at the end of the central rib, and in one instance (*Culex quasiquelidus*, Theo.) in having a dark patch or cloud at the end.

The eighth segment lies under the anal plates, and in some cases is furcate, containing the large forcipes of the male (Pl. VII, fig. 5, & Pl. VI, fig. 13). In mature pupæ the sex of the future mosquito can be seen by an examination of this part. The hairs on the segments of the abdomen are variable, but from the difficulty of judging the angle of vision, they are unreliable characters.

The respiratory trumpets are not jointed, and form a single valve outside the thoracic sac. In certain specimens, however, owing to the transparency of the pupal skin, the trumpets present the false appearance of an external articulation ; but the button-shaped object at their base is actually on the under side of the pupal skin, and below that is a tube running to the thorax of the contained imago.

I may point out that I have purposely described the abdomen of the pupa as only consisting of eight segments, as this is the appearance of the organism, when cursorily examined. The true first segment is very small and difficult to make out ; in the case of *Culex dissimilis*, Theo., which I have mounted and carefully examined, it is certainly in a degenerate condition.

KEY TO THE LARVÆ DESCRIBED.

1. Siphon long and thin, nearly as long as, or two-thirds the length of the abdomen ..... 2.
   Siphon moderately short and thin, sides never curved, one-half, or one-third the length of the abdomen ..... 7.
   Siphon short and stout, less than one-half the length of the abdomen ..... 8.
   Siphon longer than abdomen. Antennæ with dark distal joint and black spines at the tip ..... *Culex guiarti*, Blanch., p. 37. (Pl. VII, fig. 4.)
   Siphon undeveloped. (ANOPHELINÆ.) (Pl. V, fig. 20.) ..... 23.
2. Anal papillæ very long, three times as long as the anal segment. *Culex pallidothoracis*, Theo., p. 36.
   Papillæ short ..... 3.
3. Papillæ equal in length ..... 4.
   Papillæ unequal in length ..... 5.
   Siphon over ten times as long as its base ; anal segment with simple hairs on the dorsal edge ..... *Pectinopalpus fuscus*, Theo.? (II), [p. 48.
   Siphon thirteen times as long as its base ; anal segment with plumose hairs on the dorsal edge ..... *Culex pullatus*, Graham, p. 46.

5. Spines run one-sixth of the length of the siphon ..... 6.
Spines run one-quarter of the length of the siphon. *Culex aquilus*, Graham, p. 43.

6. Siphon ten times as long as its base; the longer papillæ half as long again as the anal segment ..... *Pectinopalpus fuscus*, Theo.? (1). [p. 48.
Siphon about eight times as long as its base; the longer papillæ slightly shorter than the anal segment ..... *Culex nigrocostalis*, Theo., p. 39.

7. Siphon four times as long as its base, with spines for one-third of its length; papillæ unequal and longer than the anal segment, ventral pair longer than the dorsal ..... *Culex quasigelidus*, Theo.*, p. 38. (Pl. VII, fig. 7.)
Siphon four times as long as its base, spines absent or vestigial, papillæ equal and about as long as the anal segment, the surface of which is roughened ..... *Megaculex pincerna*, Graham*, [p. 47. (Pl. II, fig. 7.)
Siphon more than six times as long as its base, with spines for one-third of its length; papillæ unequal, the dorsal pair longer than the ventral and about equal to the anal segment ..... *Culex lividocostalis*, Graham, p. 45.

8. Antennæ with plume, hairs plumose ..... 9.
Antennæ with plume, hairs simple ..... 14.
Antennæ without plume ..... 17.

9. Hairs on end of antennæ branched ..... 12.
Hairs on end of antennæ simple, not branched ..... 10.

10. With an extra joint on the end of the antennæ; spines on siphon absent or vestigial ..... *Megaculex pincerna*, Graham, p. 47.
Without such a joint; spines developed ..... 11.

11. Siphon with plumes of plumose hairs on the ventral side; characteristic plume on head near antenna ..... *Culex quasigelidus*, Theo., p. 38.
Siphon with plumes of simple hairs on the ventral side; plume on head simple ..... *Culicionaia freetownensis*, Theo., [p. 32.

12. Siphon quite four times as long as its base ..... 13.
Siphon not quite four times as long as its base; papillæ unequal, double as long as anal segment, dorsal pair one-third longer than the ventral ..... *Culex albovirgatus*, Graham, p. 41.

13. Siphon more than four times as long as its base; two rows of scales on the comb; papillæ only slightly unequal, the longer nearly twice as long as the anal segment ..... *Culex duttoni*, Theo., p. 34. (Pl. V, fig. 2.)
Siphon four times as long as its base; three rows of scales on the comb; dorsal pair of papillæ are nearly double the ventral which are nearly equal to the anal segment ..... *Culex dissimilis*, Theo., p. 40. (Pl. III, fig. 17.)

14. Anal papillæ short ..... 16.
Anal papillæ long and tapering, at least 2½-3 times as long as the anal segment ..... 15.

15. Anal papillæ nearly equal in length ..... *Culex caliginosus*, Graham, p. 44.
Anal papillæ very unequal in length ..... *Ædimorphus domesticus*, Theo., p. 31.

* These two species appear again under 8.

16. Anal papillæ equal in length; siphon very hairy on the ventral side.
Culiciomyia cinerea, Theo., p. 33.
(Pl. V, fig. 6.)
Papillæ not equal in length; siphon without such hairs. [p. 49.
Myxosquamus paludosus, Graham,
(Pl. V, fig. 15.)
Papillæ unequal; spines on siphon run for $\frac{5}{12}$ of the length followed by a plume ..... *Scutomyia marshalli*, Theo., p. 30.
(Pl. IV, fig. 16.)

17. Papillæ short, or moderate in length, less than three times the length of the anal segment .. .. 18.
Papillæ very long and thin, more than four times as long as the anal segment ..... *Ædimorphus punctothoracis*, Theo., [p. 31.

18. Siphon short and stout, less than or about $2\frac{1}{2}$ times as long as its base .. 20.
Siphon at least 3 times as long as its base ..... 19.

19. Face with four very thick hairs; papillæ shorter than anal segment.
Uranotænia balfouri, Theo., p. 50.
Face without such hairs; dorsal papillæ at least equal to the length of the anal segment, the ventral papillæ strikingly small.
Stegomyia pollinctor, Graham, p. 29.

20. Siphon of peculiar shape, with very rough surface, and spined and plumed on the whole length of the ventral side. [p. 36.
Culex tigripes, Grandp., var. *fusca*, Theo.,
(Pl. III, fig. 13.)
Siphon of normal shape and with smooth surface ..... 21.

21. Abdomen dorsally studded with short triple or stellate hairs, moderately hairy ..... *Stegomyia africana*, Theo. p. 27.
(Pl. III, fig. 3.)
Abdomen strikingly hairy ..... *Stegomyia africana*, Theo., immature form. (Pl. III, fig. 7.)
Abdomen without such hairs dorsally, or in a much less developed state ..... 22.

22. Siphonal spines running very diagonally .... *Stegomyia apicoargentea*, Theo., p. 28.
(Pl. V, fig. 9.)
Siphonal spines running nearly parallel with the sides.
Stegomyia fasciata, F., p. 25.

23. Antennæ without plume ..... 24.
Antennæ with plume ..... *Myzorhynchus mauritianus*, Theo., p. 24.

24. With small palmate hairs ..... *Pyretophorus costalis*, Lw., p. 20.
With very large palmate hairs ..... *Cellia pharoensis*, Theo., p. 22.
(Pl. VI, fig. 10.)

Key to the Pupæ described.

1. Trumpets longer than half the length of the thorax * ..... 2.
Trumpets shorter than half the length of the thorax ..... 5.

2. Anal plates of unusual shape and having a slight serration on the edges.
Megaculex pincerna, Graham, p. 47.
Anal plates of normal shape ..... 3.

* This is a character of which it is very difficult to be certain in some cases—the pupæ with rather long trumpets therefore appear again at 12.

3. The small plumes on the seventh (anal) segment are of branched hairs .. 4.
The small plumes on the seventh segment are of simple or subplumose hairs ..... *Culex nigrocostalis*, Theo., p. 40.
Culex lividocostalis, Graham, p. 45.
The small plumes on the seventh segment are of plumose hairs.
Culex pullatus, Graham, p. 46.

4. The anal plates have a dark cloud or stigma in the centre, the trumpets have a lighter ring or band in the middle .. *Culex quasigelidus*, Theo., p. 39.
Without such a stigma ..... *Culex guiarti*, Blanch., p. 38.

5. The trumpets though short, are stout or very much developed laterally, with very wide mouths, the openings of which end in a sharp angle on the inner side. (ANOPHELINÆ) ..... *Pyretophorus costalis*, Lw., p. 22.
Cellia pharoensis, Theo., p. 23.
Myzorhynchus mauritianus, Theo., p. 24.
Trumpets with ordinary normal openings ..... 6.

6. With short trumpets, not longer than the ANOPHELINÆ ..... 7.
With longer trumpets ..... 11.

7. Anal plates of unusual shapes ..... 8.
Anal plates normal as in *Cellia* ..... 9.

8. With two long hairs in front of the thorax .. *Culiciomyia cinerea*, Theo., p. 34.
Without such hairs ..... *Uranotænia balfouri*, Theo., p. 50.
Myxosquamus paludosus, Graham, [p. 49.

9. With tree-like plumes of branched hairs at the base of the thorax and with the anal plates sometimes with ciliated edges.
Stegomyia fasciata, F., p. 25.
,, *apicoargentea*, Theo., p. 29.
,, *africana*, Theo., p. 28.
Thorax without such plumes, but with a distinct thick pubescence in the same place ..... 10.

10. With two long hairs in front of the thorax .. *Culiciomyia theobaldi*, Theo., p. 33.
Without such hairs; all pubescence abnormally short. [p. 32.
Ædimorphus punctothoracis, Theo.,

11. With rather wide-mouthed trumpets ..... 12.
With narrow-mouthed trumpets ..... 13.

12. With long plumose hairs on the abdomen .. *Culex dissimilis*, Theo., p. 41.
Without such hairs ..... *Culex tigripes*, var. *fusca*, Theo., p. 36.

13. With the plumes on the seventh segment of branched hairs ..... 14.
Plumes absent on the seventh segment; only a single hair present.
Ædimorphus domesticus, Theo., p. 31.
Plumes on the seventh segment of simple or subplumose hairs.
Culex nigrocostalis, Theo., p. 40.
Culex lividocostalis, Graham, p. 45.

14. Anal plates with a dark stigma in the centre; the trumpets have a lighter ring or band in the middle ..... *Culex quasigelidus*, Theo., p. 39.
Anal plates without such stigma ..... 15.

15. With stellate hairs on the edges of the abdominal segments.
Culex guiarti, Blanch., p. 38.
(Pl. VII, fig. 3.)
Without such stellate hairs ..... *Culex albovirgatus*, Graham, p. 43.
,, *caliginosus*, Graham, p. 45.
,, *duttoni*, Theo., p. 35.

1. Pyretophorus costalis, Lw.

LARVA.

In the mature larva, which from the smaller size of the plumes and the great amount of confervoid growth is, probably, a quiescent stage, the head is very small in proportion to the thorax, but this condition is not maintained through the various larval moults, as in Dr. Graham's series there are four different stages, which I shall describe separately, under the obvious character of size :—

Larvæ 3 mm., 4½ mm., and 6 mm. long. Those of the length of 3 mm. are of two types :—

Type I.—*Head nearly as large as the small thorax.*

Type II.—*Head of usual Anopheline type, half the width of the thorax.*

a. (Type I).

Head nearly as large as the small thorax. Antennæ without plume ; two spines are present at the end, and several hairs, one of which is branched (Pl. VI, fig. 2). In one of the two specimens the antenna has a darker tip. Eye large, with pigment spot behind. Brush very bushy ; the plumes on the face are of feathered hairs ; the plume on the mandible shows prominently at the base of the antennæ. The base of the head seen from above, shows a dark chitinous collar ; on the dorsum this is broken in the median line.

The thorax is scarcely differentiated, but is very hairy with large plumes of feathered hairs.

The first three segments of the abdomen bear feathered hairs laterally ; and on the dorsum paired palmate hairs are present on the second to the seventh segments (Pl. V, fig. 22). The combs seem homologous with the rows of spines which form lateral supports to the rudimentary siphon ; in this species they consist of a double row of spines, a short one in front and a long one behind (Pl. V, fig. 20).

The siphon may be said to be differentiated but is only membranous.

The anal segment is long, with still longer hyaline papillæ ; there is a dorsal plume of peculiar long branched hairs, and the ventral beard is strong, and springs from a bulb ; it also consists of long branched hairs (Pl. V, fig. 19).

Described from two larvæ.

b. (Type II).

On these larvæ, the antennæ are without branched hairs or the branches are very minute ; the eyes are very small, apparently only the pigment spot remains ; the collar at the base of the head is very much broader ; the thorax is subglobular and well marked ; the abdomen bears five pairs of palmate hairs, similar in shape and size to those on type I.

Described from three larvæ.

c. 4½ mm. larvæ.

Head small, but not so small as the head in (*b*). The eye with a darker pigment in front (dorsal view); all the plumes on the face are of single-feathered hairs. The hairs at the end of the antennæ are branched, but are difficult to see; the collar is broader than in (*a*), but narrower than in (*b*).

The thorax is well differentiated; the anterior dorsal plumes are short, but the ventral plumes are much larger, there being four large ones on the third segment. There are two simple hairs anteriorly on the under side of the first segment with a short curved bristle at the base; all the other hairs are feathered (Pl. VI, fig. 3).

The abdomen has on the first three segments two lateral long feathered hairs, one above the other. There are small palmate hairs on the dorsum of the first segment, and on segments 2–7 palmate hairs of the same large size as in (*a*). The comb is much of the same type.

The siphon is rather less differentiated than in (*a*), but this cannot be stated with certainty.

Anal segment and papillæ much as before, but the ventral beard is exceedingly large.

Described from three larvæ.

d. 6 mm. larvæ.

The head is very small, 5 units of breadth as compared with 11 of the thorax. The antennæ have now a serrated inner edge; the collar is very broad seen dorsally, and the brush very prominent. The eyes are again large with a pigment spot behind.

Thorax very large; the surface is wrinkled on the dorsum, and on the ventral side bears a regular pattern (Pl. VI, fig. 1). All the plumes and hairs are shorter than in the previous stage; the simple hairs noticed then are again present, and appear to mark the limit of the anterior segment.

The abdomen has plumes of feathered hairs on the first three segments, but only simple double hairs on the others. The palmate hairs appear very liable to denudation, as one only is present on the seventh segment, in one specimen; on the other, one can be seen on the third segment and a pair of modifications (Pl. V, fig. 21) on the first segment. The bars and spots figured by Nuttall and Shipley on the dorsal segments can be made out in this species (Pl. V, fig. 23).

Both the larvæ have vorticellæ and diatoms, besides algal growth, on them.

The character of the comb remains the same, four short spines followed by a long one; the anal armature as regards the plumes is less, but the papillæ appear constant.

Pupa.

The pupa has small trumpets, hollowed out on the inner sides; the plumes on the seventh segment are characteristic in structure, being a modification of a branched hair. The anal plates have two ribs developed, the central or inner ones bearing rather curious wavy hairs (Pl. VI, figs. 4, 5 & 6).

Length of thorax 2 mm.

Described from ten larvæ and three pupæ.

[Larvæ and pupæ found in large water-holes and in the road puddles containing opaque water, especially when such water has been fouled by the excreta of cattle or of man. This is the commonest Anopheline larva and can be found readily from April to November and probably all the year round. The colour and markings of the larvæ differ greatly at different ages.—W. M. G.]

2. Cellia pharoensis, Theo.

Larva.

The larvæ of this species brought home by Dr. Graham are also of various stages; there are two of over 3 mm., and three of 4½ mm. in length.

The two smaller larvæ present diversities of structure in the face, antennæ and palmate hairs.

a. Head nearly as broad as the thorax, certainly longer, even leaving out the space occupied by the brushes which are large; the colour is rather dark. The antennæ are light in colour, as are also the rather weak spines at the tips. The plumes on the face seem represented by very minute stellate hairs, but those on the under side show as outer plumes, and consist of a single very much feathered hair, which is as long as the antennæ; the eyes are long and comparatively thin, and have a large pigment spot at the lower end.

The thorax is small: it bears the usual plumes of feathered hairs and the two simple hairs noticed in *Pyretophorus costalis*. There are rather characteristic thick feathered hairs in the middle of the dorsal side, each with a decided socket.

The abdomen has feathered plumes on the first three segments; palmate hairs are present on the third to the seventh segments which are rather small in size compared with the very large type found in other stages. They are best seen on a semi-ventral, or semi-dorsal view, the larva lying partially on its side. The comb is closely similar to that in the preceding species, but the long spines are longer, and the pigment differs.

The anal segment is large and of much the same type as in the preceding species.

Described from a single specimen.

b. This differs from the above, in having the antennæ with a black hair at the tip, and in having six plumes on the face, besides the two outer under plumes (Pl. VI, fig. 7).

The thorax has the two characteristic hairs more markedly socketed, and the two simple hairs have quite a spine at their base (Pl. VI, fig. 8).

The palmate hairs on the abdomen are very large, though that on the first segment is smaller; fourteen are present, a pair on each segment; sixteen curved scales can be counted on each hair, rising from a stout base; the complete hair fills a space, at its greatest width, equal to $\frac{2}{3}$ of the length of a segment (Pl. VI, fig. 10).

Described from a single specimen.

c. Larvæ of $4\frac{1}{2}$ mm.

The head is still very large in proportion, and I think that it is not the mature form. It is the same colour as (*b*). The antennæ have two strong hairs on the end, and a small dark plume between them. The face is similar to that of (*b*), as are also the eyes.

The thorax is even more hairy than in (*b*); the simple hairs are present, but like the two posterior plumes they are socketed in a striking outgrowth and have spines at their bases on the ventral side; the dorsal side shows the characteristic hair referred to in previous stages, and this also has a markedly chitinous socket (Pl. VI, fig. 18); the anterior plumes are short; on either side of the median line is a pair of short stiffly haired plumes, rather striking in character; they are also present in (*b*) in a much less developed condition, but not in (*a*); all these plumes are feathered.

The palmate hairs are of the same type as in (*b*). The scales of the comb are darker (Pl. VI, fig. 9).

The papillæ are much contracted at their base, pointed and hyaline in colour; ventral beard large, and of the same type as in the previous species.

Described from three specimens.

Pupa.

The pupa is characterised by remarkably wide-mouthed trumpets; the plume is present on the seventh segment; of the same type as *Pyretophorus costalis*, Lw., but the spines on the other segments are stronger. When the imago is a male the forcipes are contained in two hyaline sacs which come down below the middle of the plates (Pl. VI, figs. 11, 12 & 13).

Length of thorax under 2 mm.

Described from five larvæ and one pupa.

[Larvæ and pupæ found in a large water-hole behind the Medical Research Institute and in road puddles in June and July. They resemble the larvæ of *Pyretophorus costalis*, but are somewhat longer and more slender.—W. M. G.]

3. **Myzorhynchus mauritianus**, Theo.

Larva.

Two stages are present, but as they are similar in all important characters, I shall not describe them separately.

The whole larva is stout and very dark in colour; the head is very chitinous, almost opaque, and much smaller than the thorax. The antennæ have a plume in the middle of simple dark hairs; there are two strong spines at the end, and between them a branched hair (Pl. VI, fig. 17). Above the brushes are two characteristic fan tufts of short black hairs which are less developed in the immature form (Pl. VI, figs. 14 & 15); the usual plumes of the face are of strong dark hairs and are also less developed in the immature form; the eyes are very small and the pigment spot behind them is darker.

Thorax rather small, the simple hairs have only a short spine at their base; the anterior dorsal plumes are very short, but some well-developed longer ones are found on the ventral side, and on either side of the median line are two branched hairs and 5–8 simple hairs.

On the abdomen, besides the usual plumes and accessory hairs, are large beautiful palmate hairs, of rather dark pigmentation, which differ in the shape of their scales from those of the two previous species, while the points are hyaline. They are found on both forms, being large on segments 3–7, and rudimentary on the first and second segments (Pl. VI, fig. 16). The comb consists of very long spines with shorter ones at the base (Pl. VI, fig. 19).

The anal segment is serrated and ciliated on its lateral edges, and has the papillæ subequal and a little longer than the segment. The beard is strong but much denuded in the mature larvæ.

Mature larvæ nearly 6 mm. long; less mature form thinner, and with less developed thorax, but nearly as long.

Pupa.

The mouth of the trumpets is even larger than in the preceding species, and the outer buttress of the anal plates is less developed (Pl. VI, fig. 20).

Described from five larvæ and one pupa.

[Larvæ and pupæ found in the large water-holes behind the Institute and in road puddles in July and August. In young larvæ the abdomen is black with 4 to 6 pale bands: full grown larvæ have a black abdomen with usually two brown bands.—W. M. G.]

4. **Stegomyia fasciata**, F.

LARVA.

Small, with a large head, which is lighter in colour in the earlier, than in the more mature stages. Antennæ light, very simple, without any plume, and the few minute hairs that are present at the tip are only a shade longer than the width of the antenna. Face without long plumes, with only single or double hairs (all apparently varying in the different stages of growth) or short quintuple or quadruple hairs, but these seem to be constantly simple. Hairs on the labrum noticeably thick and bushy, as are also the brushes. The eyes are very small and round, but these organs are usually variable; this character is constant in all the larvæ (two stages) collected by Dr. Graham.

The thorax is small, broader than the head in only one specimen; the anterior dorsal plumes are absent, or represented by small stellate hairs; the part is well haired, the plumes on the ventral side, in the middle and posterior portion, have a large chitinous bristle or hook at their bases. All the plumes and hairs are with difficulty seen to be subplumose, and that only at the bases.

The abdomen has long double hairs (subplumose at their bases, like those on the thorax) on the first five segments, besides numerous stellate and short hairs, all being simple. The comb, though consisting of very large dark scales, is only easily seen on light larvæ; it consists of a single row of 8–9 barbed scales; those nearer the anal segment appear smaller and are difficult to see. The siphonal, sub-siphonal and anal plumes are all small and of simple hairs.

The siphon is rather more than a quarter of the abdomen in length (unreliable character) and is about $2\frac{1}{2}$ times as long as its own base; the spines which are long, and much barbed at their bases, run for half the length, nearly parallel with the sides of the siphon; their number and shape are not reliable characters, as the first is variable, and the second has its counterpart in many species. The spines are followed by a triple hair, and the valves are small.

The anal segment is very short, only a little longer than the breadth of the siphon; the papillæ are equal, stout, and with strikingly blunt ends; they are twice as long as the segment; the dorsal edge carries 4 (?) long simple hairs and there are some of similar length on the ventral edge—the ventral beard is on the end but is very liable to denudation.

Length about 4–5 mm.

PUPA.

The pupa has short trumpets, and large tree-like plumes of branched hairs at the base of the thorax (only one can be seen in one focus at the lateral view).

There are single hairs on the abdomen, and plumes of branched hairs on the seventh segment which are longer in a more mature pupa. The anal plates are subcircular with fine dark short hairs on the lower edges.

Greatest length of thorax $1\frac{1}{2}$–2 mm.

Described from four larvæ and five pupæ.

[Larvæ found in a small quantity of water in an empty fish-tin upon the dust-heap behind the kitchen.—W. M. G.]

Siphon and anal segment of *Stegomyia fasciata*, F.

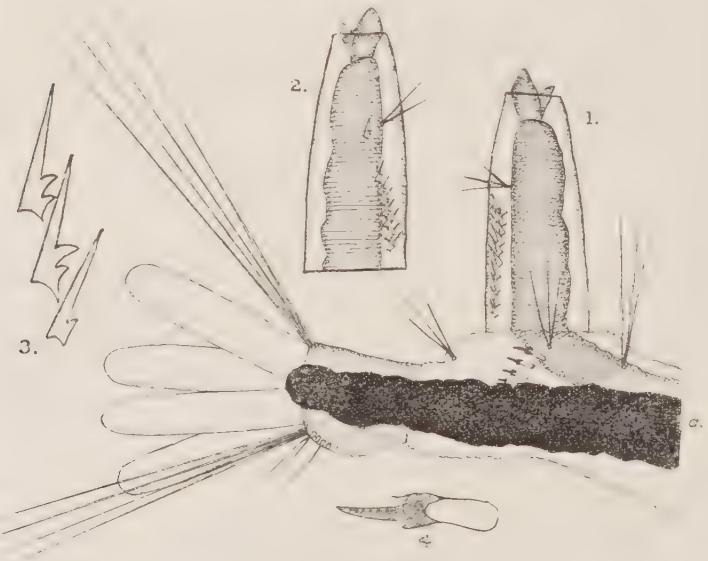


Fig. 1. Lateral view of the parts: *a*, bowel; it will be noticed that the view of the comb is obscured, though the remaining scales are above the bowel; they are eight or nine in number. The structures are those seen with a magnification of about 60 diameters; the animal, quite unprepared for microscopic examination, lying in a trough of formalin, or in water. The long hairs on the ventral side of the anal segment have been curtailed by the exigencies of space; they are as long as those on the dorsal edge. The ventral beard has been denuded, and is drawn as it exists on the specimen.

2. The same siphon reversed showing the abnormal condition of the spines on the left side.

3. The three lowest spines on the left side drawn larger, though seen with the same magnification.

4. A scale of the comb drawn larger but seen with the same magnification as fig. 1. Goeldi figures more teeth on the part, but these obviously require much more magnification for resolution.

5. Stegomyia africana, Theo.

LARVA.

The head is rather small and peculiar in shape, dark in colour and very chitinous. Viewed both dorsally and ventrally, the brush, which is so prominent in the Anopheline and other larvæ, does not show, or is only partially visible. The antennæ are without plumes, and only carry a few short hairs at the end. Face without plumes, and with only short stellate hairs on each side of the median line, and two longer ones, which appear to be split at their ends, or they may possibly be two hairs; all these are simple.

Thorax rather small, with the usual plumes, but these are of simple hairs; the dorsal anterior hairs are short, and also simple. Some of the side plumes are slightly pubescent at the base. The plumes on the ventral anterior sides or ends of the thorax have chitinous sockets and a rather prominent bristle at the base.

The abdomen is long and thin, and is symmetrically studded with an arrangement of short triple hairs on the dorsum, and several long simple hairs on each segment (Pl. III, fig. 3). It is very difficult to get a view of the sub-siphonal and siphonal plumes, but they consist of but a few simple hairs in the usual places; the relative proportions are the same as usual, the siphonal being smaller than the sub-siphonal. Viewed dorsally the combs appear as a series of short spines on each side of the eighth segment, but a lateral view shews them as a single row of about ten scales.

The best way to see the lateral view of the siphon is to prop the larva up with a piece of fine bent wire or entomological pin. It is only slightly over twice the length of the base; the spines run in a curve, very close to each other, and are at least 12 in number; at their upper end is a double hair; the valves are small (Pl. III, fig. 4).

The anal segment is short, with the papillæ a little longer, subequal and with very stout bases; the hairs on the dorsal edge are long, but the ventral beard is scanty, consisting of only a few simple hairs.

Larva about 4 mm. in length.

The following is a description of two immature larvæ of the same species :—

Head very large, dark and chitinous; in one specimen it is darker than in the other, which is much lighter. Antennæ small and without plume; no plumes on the face, only single or stellate hairs; it has also the two split hairs found in the previous form, which it much resembles in the head.

Thorax rather small; instead of the anterior hairs it has four large stellate hairs; it is also studded with similar hairs on all the sides, and has longer single hairs standing out from the shorter stellate ones. These single hairs are also collected, as in the mature stage, into plumes with a strong bristle at their base, and are slightly pubescent on their lower part (Pl. III, fig. 7); they occur in both stages also on the ventral side.

The abdomen is haired in the same manner as the thorax ; the hairs being stiff and short, stout at the end, and of a dark colour, give this larva quite a spiny appearance. Comb with a single row of about eight very long scales, but the exact number is uncertain (Pl. III, figs. 9 & 10).

The siphon is short and stout, being less than $\frac{1}{3}$ of the length of the abdomen : and less than $2\frac{1}{2}$ times as long as the base; the spines are inconspicuous and difficult to see, but are exceedingly close to each other and run in a curve for about half the length ; there are long double hairs laterally ; valves very small (Pl. III, fig. 8).

The anal segment is as long as it is broad, with four stout papillæ which are a trifle longer than the segment and subequal (papillæ short and subequal) ; in the two larvæ examined they have a spotted appearance, but this may be accidental. There are eight long simple hairs on the dorsal edge: ventral beard thin, consisting of 12–16 very long hairs.

Length of larva $3\frac{1}{2}$ mm.

Pupa.

With short tubes; the hairs at the base of the thorax are well marked, forming a series of plumes; the plumes on the seventh segment are also noticeable ; but the most characteristic thing is the ciliated anal plate (Pl. III, fig. 6), the rib or thickening of which is also unusually chitinous (Pl. III, fig. 5). A second pupa is figured to show the variation in the shape of the thorax (Pl. III, fig. 11).

Length of thorax less than 2 mm.

Described from four larvæ and two pupæ.

[Larvæ found in the water contained in the butt end of a large bamboo, early in June. The bamboo was cut through with a saw between the internal discs. These larvæ developed very slowly in the glass jar. Larvæ of *Scutomyia marshalli*, Theo., were also present.—W. M. G.]

6. **Stegomyia apicoargentea**, Theo.

Larva.

Head rather small, very chitinous and semiglobular, so that the brushes do not usually show, when they are looked at from the dorsal side. Antennæ simple, without a plume, and with only a few short hairs at the tip ; all the part is dark, but is of a lighter tinge at the end.

Thorax with the usual plumes, but these are of simple hairs—at the most there may be a little secondary pubescence on the lower part of some, and a few may be seen with very careful focussing to be subpubescent.

There are short double and triple hairs on the sides of the abdominal segments, and there are longer double hairs on the ventral surface, all simple. The siphonal and sub-siphonal plumes are also simple.

The comb is very difficult to make out from a lateral view, but by propping up the larva on a much twisted and bent piece of metal I was able to count a row of ten, rather peculiarly shaped scales (Pl. V, figs. 11 & 12).

The siphon is very dark, short and stout, about twice as long as the base; the spines are strong, serrated, and run up in a curved line from the base to nearly the middle; there is a double hair (simple) beyond the spines; the valves are small (Pl. V, figs. 9 & 10).

The anal segment is short with stout subequal papillæ, light yellow in colour; one specimen has one pair almost hyaline, though the other pair is of a yellow colour; the papillæ are longer than the segment; there are long hairs on the dorsal edge, and the beard is on the end and rather thin, but very long, equal to the long hairs on the dorsal side.

Larva less than $3\frac{1}{2}$ mm. in length.

PUPA.

The pupa has very short stout dark trumpets, and very marked plumes on the thorax. There are no plumes on the sixth segment, only a single hair on each corner; the plumes on the seventh segment are small and of subplumose hairs; the anal plates have some minute scales on their basal outer edge, and the ribs are very chitinous (Pl. V, figs. 13 & 14).

Length of thorax less than 2 mm.

Described from three larvæ and three pupæ.

[Larvæ found in the water in an earthen fetich-pot standing under a palm tree outside Yaba village in June.—W. M. G.]

7. **Stegomyia pollinctor**, Graham.

LARVA.

Large-headed forms with rather thin abdomen.

Head not quite so broad as the thorax, dull opaque yellow, and with rather marked pigmentation; the base of the mandibles, the base of the under surface, the parts leading to the under lip, and the usual marks at the bases of the brushes, are all of a darker colour. The antenna is dark and has, or appears to have, a few simple hairs in the usual place of the plume; the solitary specimen is much damaged and one antenna is missing. The maxillæ have dark hairs at their ends, and the brushes are large. The face is much denuded, but on one side a plume remains, small in size and having four simple hairs; there are besides a few single and double simple hairs. The eyes are very large, as are also the pigment spots behind them.

The thorax has the usual plumes, small in size and of subplumose hairs; and on the anterior portion of the dorsum, two stellate hairs of fair size, close to and on either side of the neck; these, if they are a constant character, are obvious, and of use in determination.

The plumes on the first two segments of the abdomen are short and subplumose; the hairs on the other segments are simple and consist of moderately long hairs on the ventral sides, with stellate hairs higher up; the seventh segment has from three to four minute tufts on its sides, and a larger quadruple hair (the hair equal to half the breadth of the segment); all these

hairs are paired laterally. The comb appears from the ventral side to consist of small black scales, each scale with a central spine flanked by some indistinct ciliation. Owing to the dark colour of the larva I cannot see anything laterally. The sub-siphonal plume consists of simple hairs.

The siphon is short (six units as compared with thirteen of the abdomen), and is about $3\frac{1}{2}$ times as long as the base : very dark, and darker round the base ; the spines are very dark, close to each other, and becoming longer as they run up for nearly a third of the length of the siphon : they are slightly serrate on the outer base. The valves are very small (Pl. VII, figs. 10 & 11).

The anal segment is small, little shorter than twice the width of the base, on the dorsal side; the papillæ are quite yellow and do not contract at the base ; the ventral pair is strikingly small, half the size of the dorsal, which equals the segment. The dorsal edge is slightly serrated with some minute spines ; it carries besides two long, and some shorter hairs ; the ventral beard is a little longer than the papillæ and runs for nearly half the ventral surface. The figure shows the state of the segment on the larva as I found it ; the under hairs are probably denuded (Pl. VII, fig. 12).

The larva is 5 mm. long, siphon $\frac{4}{5}$ mm.

Described from one specimen ; pupa unknown.

[Larvæ found in a hollow tree in August ; they were small and did not become imagines till October.—W. M. G.]

8. **Scutomyia marshalli,** Theo.

Larva.

Head as large as, or larger than the thorax, dark, smooth, and semiglobular. Antennæ large, no constriction at the plume, which is of subplumose hairs ; the end is darker with a few short hairs. The brush is not visible dorsally ; all the face plumes are large and of plumose hair, being very stiff and fan-like.

Thorax and the first two segments of the abdomen with very large side plumes, the latter also having minute stellate hairs. The comb is difficult to see, and consists of two rows of minute scales. Sub-siphonal plumes large but of simple hairs.

Siphon stout, highly chitinised, less than half the length of the abdomen (as 6 to 15) ; spines strong, barbed on their lower sides, they run for $\frac{5}{12}$ of the length, and there are plumes of six simple hairs above the spines on each side (Pl. IV, figs. 16 & 17) ; it is quite four times as long as the base.

The anal segment is longer on its dorsal side than its ventral (as 10 to 7) ; the papillæ are yellow in colour, short, with pointed ends and unequal ; the longer pair are shorter than the segment : there are very long hairs and a shorter plume on the dorsal edge, and a bushy strong ventral beard : all the hairs are simple and longer than the papillæ (Pl. IV, fig. 18).

Length of larva $2\frac{1}{2}$ mm., siphon $\frac{2}{3}$ mm.

No pupa.

[Larvæ found in water in the butt-end of a large bamboo early in June.—W. M. G.]

9. **Ædimorphus domesticus**, Theo.

LARVA.

This larva is very like that of *Culex caliginosus*, Graham, in the shape of the head, antennæ, and the simple character of the hair of the plumes, but can at once be separated on the characters of the siphon; the comb also has only six scales, though these, when seen from the side, appear alike in type.

The spines on the siphon are at least fourteen in number, placed in a close and regular row; at their upper end they are longer and more separated, and quite in the upper third is a small stellate hair like that in *C. caliginosus*.

The siphon is over five times as long as its base (Pl. III, fig. 2).

The anal segment is also similar except the papillæ, which are very unequal; the longer are nearly four times as long as the segment (55 units against 15) and much longer than the shorter pair (55 units against 35).

The larvæ are 4 mm. long.

PUPA.

The pupa is even harder to differentiate from that of *Culex caliginosus*, except that the hair at the base of the thorax seems more bushy, and it appears not to be so broad from a dorsal view; but it can be distinguished by the absence of the small plume on the seventh segment, which is represented only by a single hair (Pl. II, fig. 16).

Length of thorax $1\frac{3}{4}$ mm.

Described from seven larvæ and two pupæ.

[Larvæ found in borrow-pits along the side of the railway early in June.—W. M. G.]

10. **Ædimorphus punctothoracis**, Theo.

LARVA.

Head as broad as thorax; with curious hyaline bladders on the mouth by the maxillæ, quite singular in appearance; antennæ without plume (Pl. I, fig. 15).

The hairs of the plumes on the face are triple and quadruple, but they appear serrate, not even subplumose. The side plumes on the thorax are distinctly bushy, and have the usual plumose hairs.

The abdomen has some long single hairs standing out from the sides, which are also serrate; a higher magnification shows that they bear a very minute pubescence; they appear characteristic in structure. The plumes at the base of the siphon are large, with plumose hairs. The comb can only

be seen with difficulty; the scales are large, and taper somewhat suddenly from a broad base to a point.

The siphon is characteristic; rather short and stout, and four times as long as its base; remarkably long strong spines reach halfway up; between the rows of spines are two plumes of stiff straight hairs which have some pubescence on them; the valves are small (Pl. I, fig. 16).

The anal segment is short, only slightly longer than its base, with four very long hyaline papillæ, which are $4\frac{1}{2}$ times as long as the segment; there are some hairs on the dorsal edge which are longer than the papillæ in some specimens and shorter in others, and a moderate beard and some shorter hairs on the ventral side, all simple.

Length of larvæ, which are very curved, 3 mm., siphon $\frac{2}{3}$ mm.

Pupa.

This is rather characterless and light in colour; the plume on the anal segment is very small, with only a few simple hairs: the trumpets are small (Pl. I, figs. 17 & 18).

Length of thorax $1\frac{1}{4}$ mm.

Described from three larvæ and three pupæ.

[Larvæ found in borrow-pits along the side of the railway from June to middle of July. The behaviour of the larvæ is peculiar. They very rarely come to the surface of the water, but lie upon their backs at the bottom with the anal gills widely expanded, or crawl sluggishly about upon the sides of the jar.—W. M. G.]

11. **Culiciomyia freetownensis**, Theo.

Larva.

Head moderate in size and rather dark in colour. Antennæ all pale, with the usual fan-shaped plume, the hairs being only moderately plumose and the secondary hairs fewer and shorter; with three short simple hairs and a short spine at the tip. On the face, six plumes of moderate length (plumose) may be seen from a dorsal view, and behind these a pair of small stellate hairs, close to each other, lie on each side of the median line.

Thorax much as in *Culex pullatus*, Graham.

The abdomen with large stellate subplumose hairs on segments 3 to 7: there being two hairs on each side of each segment, one near the dorsum and the other lower down. Sub-siphonal plumes long, but containing few hairs; siphonal plumes also thin; the anal plumes are subpubescent, but this is very difficult to see, and is more marked in some specimens than others. Comb difficult to see laterally; from the dorsal view, it shows as a number of curved spines.

Siphon short and stout, scarcely three times the base in length, with

marked valves at the end, and 4–5 pairs of stiff triple long hairs (subplumose) on the same line as the spines, which are obvious, and run about half-way up; there is a pair of compound hairs on the dorsal side, and lateral hairs (all subplumose) as well (Pl. I, fig. 10).

The anal segment is about as broad as it is long, and has four stout papillæ with blunt ends, which are nearly equal in length. On the dorsal edge are two long, and a number of shorter, strong hairs. The ventral beard is only moderate in size, at its longest not equalling the papillæ. All the hairs on the anal segment are simple.

Larva 5 mm. in length.

Pupa.

The trumpets are short, the hairs at the base of the thorax are paired plumes (Pl. I, fig. 11), and the stellate hairs on the segments of the abdomen are well marked. Two long double hairs which spring from near the eyes are rather conspicuous, and the small plumes on the last two segments are of plumose hairs (Pl. I, fig. 12).

Length of thorax $1\frac{2}{3}$ mm.

Described from six larvæ and eight pupæ.

[A raft of about 140 eggs was laid upon some water in a glass jar in the veranda of the bungalow at the end of May. Eggs hatched in two days; larvæ became pupæ in eight days; pupal stage lasted three days.—W. M. G.]

12. **Culiciomyia cinerea**, Theo.

Larva.

Large stout larvæ, with the head considerably narrower than the thorax, and rather dark in colour (deep reddish brown—almost vandyke). Antennæ with a plume of simple, or sub-simple hairs; distal joint fairly stout, more so than usual; very short hairs on the end (Pl. V, fig. 5). Brush and mouth-parts hairy; the plumes on the face all developed, moderate in size but of quite plumose hairs. Eyes large, with the pigment spot not at all conspicuous.

Thorax with the usual normal plumes of plumose hairs.

The abdomen has on the third to the sixth segments symmetrical quadruple hairs of moderate length, which are subplumose, and on the ventral side symmetrical long triple hairs, which are also subplumose, but difficult to see. The abdomen in all the specimens is quite dark, which renders it difficult to make out the comb without much manipulation; when clearly seen, it shows as a row of small scales close to each other, followed by a second row of longer, more separated scales, and a third row of about five scales. Siphonal and sub-siphonal plumes particularly large, the latter reaching to the end of the anal segment.

The siphon is a little less than three times the length of the base, very dark, and with a curious appendage at its base, which is very unusual in the species here described (Pl. V, fig. 6). It has many plumes of subplumose hairs on its ventral side ; the spines do not begin at the base, being short and dark, and about 5–6 in number. There are also lateral quadruple hairs.

The anal segment is short, but is remarkable for its papillæ, which are longer than the segment and subequal, two of them being distinctly chitinised, and the other two darker in colour than the usual type. There is a tuft of long hairs on the dorsal edge : the beard is at the end, and not on the ventral side ; at its longest it equals the papillæ in length ; all the foregoing hairs are simple, but there are lateral plumes inserted in the last third, which are subplumose.

Larva 4½ mm. long, siphon ⅔ mm.

Pupa.

The pupa has short trumpets, which are more yellow in colour at their ends than usual, and there are rather long characteristic hairs on the front of the thorax ; it is broad and consequently the hair characters are at various foci ; the plumes on the sixth and seventh segments are large and plumose. All the long hairs on the abdomen are subplumose and not at all easy to see.

But the most striking feature is one that is even more difficult to see ; the easiest way is to break off the last three segments of the abdomen, and it will be seen that the anal plates are notched in the centre (Pl. V, figs. 7 & 8).

Length of thorax 2 mm.

Described from six larvæ and three pupæ.

[Larvæ found in July in the same barrel of stinking water which contained *Culex dissimilis*, Theo. ; they are very active in their movements.—W. M. G.]

13. **Culex duttoni**, Theo.

Larva.

Head very large in proportion to the thorax, light in colour, and rather of the type of *Culex pallidothoracis*, Theo.

Antennæ with a large tuft of plumose hairs, and the hairs at the end, like those in *Culex albovirgatus*, Graham, and *C. dissimilis*, Theo., are branched, perhaps a little more so than in the others (Pl. V, fig. 3). Brushes conspicuous ; the mouth-parts are bushy, but the plumes on the face are but moderate in size, though of plumose hairs. Eyes with strongly differentiated edges ; the pigment spot behind as in *C. pallidothoracis*, and with the small plume of simple hairs present.

Thorax scarcely differentiated, but with long plumes of plumose hairs.

The first two segments of the abdomen carry the usual plumes of plumose

hairs, but the long hairs on the other segments are only subplumose. All the other hairs on the segments are short and simple, including a number of the minute stellate form. The sub-siphonal plumes are moderate in size and are of plumose hairs, the pubescence being rather thick, though short; the siphonal plumes are small, and the anal plumes are also shortly plumose. The comb is very difficult to see; under favourable conditions it appears as an anterior row of about sixteen suboblong scales, and a posterior one of six.

The siphon is about half as long as the abdomen, stout but tapering, more than four times as long as its base, the end is light in colour for about $\frac{1}{5}$ of the length; this is followed by a dark ring which gradually becomes lighter to the base, where the usual chitinous ring is present; this character is very marked in five out of six larvæ, and in the sixth it is fairly obvious (Pl. V, fig. 2). The spines do not begin till a short way from the base; three to five are present, being rather small, and running for less than one-third of the length; they are followed by two long subplumose hairs (four, counting both rows), and in the dark ring is sometimes a single lateral hair and a short triple or double one—these appear variable; the valves at the much tapered end are small, and have a few bent short hairs on them; the contained tracheæ are large, as is usually the case.

The anal segment is short, as long as broad (it widens posteriorly), with stout papillæ of slightly unequal length; the longer nearly twice the length of the segment; they have a spotted appearance, though fairly hyaline. There are four long strong hairs on the dorsal edge; the ventral beard is small, not longer than the smaller papillæ, and mostly at the distal end.

Larva $4\frac{1}{2}$ mm. long, siphon $1\frac{1}{3}$ mm.

Pupa.

The pupæ are variable in colour, as one is quite dark, and the other quite light, and they are rather characterless; the plumes on the seventh segment are short but thick and of subplumose hairs; in the same place on the sixth segment is a triple hair. In this case the dark form is easily seen to be that of the mature pupa, as the rather large scales on the abdomen of the imago can be seen when the pupa is examined from the dorsal side (Pl. V, fig. 4).

Length of thorax $1\frac{1}{2}$ mm.

Described from six larvæ and two pupæ.

[Larvæ found in a tub of dirty water in July. The larvæ are very common in barrels, tubs and ponds in June, July and August. The egg-raft is 4 to 6 mm. long, formed of 170 to 250 bottle-shaped eggs disposed in 4 to 9 rows. The eggs are laid between sunset and dawn, and hatch in about 24 hours.—W. M. G.]

14. **Culex tigripes**, Grandpré, var. **fusca**, Theo.

LARVA.

Head moderately large, light in colour. Antennæ short and simple, plume absent, only a few short hairs at the tip. Mouth with remarkable stout chitinised hairs on the brush, which, seen with higher magnification, show a beautiful microscopic structure of minute pectination on a large portion of each hair (Pl. III, fig. 15). No plumes on the face.

Thorax well differentiated, with moderate-sized plumes of plumose hairs.

Abdomen with plumes of plumose hairs on segments 1–4 and double hairs on segments 5–7. Comb with about 30 scales in several rows, which are rather small; seen dorsally they have a spinose appearance.

The siphon is peculiar and characteristic; it has a very rough surface, and is bearded down the ventral side between the rows of spines with long plumose hairs; it is under three times as long as the base (Pl. III, figs. 13 & 14).

The anal segment is strikingly prolonged at its dorsal edge, and has an even rougher and more serrate surface than the siphon; the papillæ are short, and there is a long ventral beard (Pl. III, fig. 12).

The larvæ are 5 mm. long.

PUPA.

The pupa has rather stout trumpets; the plumes on the seventh segment consist of plumose hairs, and there are similar plumes on the sixth segment; the ribs that strengthen the anal plates carry two minute hairs instead of a spine; there are no hairs on the head (Pl. III, fig. 16).

Length of thorax 2 mm.

Described from six larvæ and three pupæ.

[Larvæ found in a large water-hole, the water of which was milky-coloured and opaque. These larvæ were very carnivorous, and fed upon other specimens of larvæ, or upon each other when other species were not available. The attack was usually made by seizing the victim's siphon near the base and biting it through. The larvæ of *Pyretophorus costalis* were found in the same water-hole. It is possible that this carnivorous larva may be useful by acting as a destroyer of the larvæ of *Pyretophorus costalis* and of *Myzorhynchus mauritianus*. Egg-raft small, rounded, of 25 to 40 eggs; the latter brown, with black apex. The eggs hatch in about 24 hours.—W. M. G.]

15. **Culex pallidothoracis**, Theo.

LARVA.

Head very large in proportion to the thorax. Antennæ covered on both joints with minute spines, and carrying a large plume of plumose hairs; the distal joint is slightly darker, and has one strong black spine at its end

and several shorter ones. Brush with exceedingly long hairs; maxilla very large. Side plumes on face very large, comprising 8–10 plumes of plumose hairs. Eyes with the pigment spot behind: a small plume of simple hairs underneath them.

Thorax scarcely differentiated, but covered with long strong plumes of plumose hairs.

The abdomen, besides the usual plumes which are of plumose hairs, has a few moderately long simple hairs on each segment. Comb consisting of seven scales, which are sharp spines, well separated, and in a single row. Sub-siphonal plume large, consisting of eight plumose hairs: the siphonal plume smaller with only four simple hairs.

Siphon nearly as long as the abdomen, thin and tapering: a shade more than eight times as long as the base. Spines marked, simple, running to nearly $\frac{2}{3}$ of the length; closer together at the base than at the upper end: four simple hairs show on the ventral side, and some at the tip; valves moderate, the tracheæ that are enclosed are noticeably thin (Pl. IV, fig. 15).

The anal segment is short, a third longer on its dorsal side than on its ventral; the papillæ are more than three times as long as the longest part of the segment, and are of nearly equal size; they taper to sharp points; a trachea can be traced down each papilla: the dorsal edge of the segment carries long hairs, half as long again as the papillæ; there is a short plume, but no beard on the ventral edge.

Length of larva $3\frac{3}{4}$ mm., siphon 2 mm.

No pupa.

[Larvæ found in borrow-pits along the side of the railway late in June. The behaviour of these larvæ resembles that of the larvæ of *Ædimorphus punctothoracis*.—W. M. G.]

16. **Culex guiarti**, Blanch. (=*viridis*, Theo., *nec* Rob.-Desv.).

LARVA.

Big headed forms with extraordinarily long siphons (Pl. VII, fig. 4). Head light, subhyaline, as broad as, or broader than the thorax. Antennæ long, and carrying a large plume of plumose hairs: distal joint dark and with three long black spines, and a fourth short one, besides a subhyaline process which is not always present; the spines are at different planes and consequently only three show at one focus, using a magnification of 60 diameters. The maxillæ carry very long hairs and the mouth-parts are very hairy—this shows best in a lateral view; the hairs on the face are much developed. The eyes are large and have a small pigment spot behind them.

The thorax is of fair size; the dorsal anterior hairs are many, and reach

forward well over the head: the lateral plumes are strong and of very plumose hairs.

The abdomen carries the usual plumes on the first two segments; these are of plumose hairs, the remaining long hairs (except the siphonal plumes) are only subplumose; on the sides and dorsum are a number of small stellate hairs, but possibly owing to denudation, I fail to recognise any symmetrical arrangement. The comb shows (dorsally) as 12–6 sharp scales, irregularly distributed, the longest being in front. The siphonal plumes moderate, the sub-siphonal fairly developed, with plumose hairs.

The siphon is considerably longer than the abdomen: 12–13 units as compared with 10 of the abdomen. The spines are few and run for less than a quarter of the length of the siphon, which is 20 times as long as its base.

The anal segment is long, being twice the length of its base. The papillæ are about the same length as the segment, but some are a little longer; on the dorsal edge are four very strong dark hairs and some of less length; the ventral beard is moderate but bushy, and runs for one-third of the segment.

The larvæ are about 5 mm. in length, siphon $3\frac{1}{3}$ mm.

Pupa.

This is characterised by very long thin trumpets and a series of stellate hairs on the dorsum of the abdomen (Pl. VII, figs. 1, 2, 3).

Length of thorax $1\frac{1}{2}$ mm.

Described from six larvæ and five pupæ.

[Larvæ found in the large water-hole behind the Institute in July.—W. M. G.]

17. **Culex quasigelidus**, Theo.

Larva.

Very dark, with large head and antennæ; head highly chitinised, quite opaque.

Antennæ with a very large plume of plumose hairs; the lower part is dark, but the part below the plume and the distal joint are much lighter in colour; it is much constricted at the root of the plume and the spines at the end are long and dark (Pl. VII, fig. 8). Brush very prominent, and also the hairs on the maxillæ. Central plumes on the face moderate, but those near the antennæ are unusually thick, the hairs not being in the same plane and being black in colour (Pl. VII, fig. 9).

Thorax differentiated, and with the usual plumes.

Abdomen with the usual plumes on the first two segments, but symmetrical

plumes of six simple hairs show on the posterior portion of most of the other segments, on the dorsum. At about the same focus, minute stellate hairs or plumes may be seen, and right on the back are a few long subplumose single hairs. The comb is very difficult to see, but by arranging the larva so as to obtain a horizontal view along the back (the head balances on the long antennæ) three unusually long strong dark spines are visible on the edge of the segment. Siphonal plumes moderate in size, sub-siphonal large, and both of plumose hairs.

The siphon is short, four times as long as the base, about one-third of the length of the abdomen ; a dark ring encircles it in one specimen which is absent in the other (Pl. VII, fig. 7). The spines are weak and run for about one-third of the length ; on the median line is a single hair, and it is followed at equal distances by four plumes of about six plumose hairs ; in the upper third are lateral triple hairs ; the valves are very large, particularly the ventral.

The anal segment is small, as are also the papillæ, which swell from a narrow base and diminish to pointed ends ; they are longer than the segment, and the ventral pair is longer than the dorsal, which is unusual ; in one specimen the ventral ones are slightly chitinised. On the dorsal edge is a curious hair, which is strong at its base and has others springing from it. The ventral beard is longer than the papillæ and runs for about a third of the segment.

Larva 4½ mm. long, siphon over 1 mm.

Pupa.

Very dark, with long and thin trumpets, which have a lighter ring in the middle ; there are plumes on both the sixth and seventh segments, both of branched hairs, and the anal plates have a distinct dark cloud in the middle (Pl. VIII, figs. 5 & 6).

Length of thorax 1½ mm.

Described from two larvæ and three pupæ.

[Larvæ found in borrow-pits in June and July.—W. M. G.]

18. **Culex nigrocostalis**, Theo.

Larva.

Head not quite so broad as thorax, light in colour. Antennæ fairly long, also light in colour, with a small, darkened, chitinous ring at the base ; plume large, with plumose hairs ; the distal joint is a shade darker than the proximal one ; it carries three long simple hairs and a spine at the end. Face with short plumes, brush rather stiffly haired, pigment spots large at base of antennæ.

Eyes strongly defined: under part subtriangular at the corner: accessory posterior pigment spot large and black in some specimens—variable.

Thorax well differentiated, with the usual plumes; in some individuals the hairs appear to have lost their pubescence. One specimen shows a symmetrical pattern on the ventral surface like *Pyretophorus* (Pl. VI, fig. 1).

Abdomen rather long and thin: plumes on first two segments rather short: weak stellate hairs on all other segments—very light in colour. Comb large, consisting of a patch of 40–50 scales of moderate size (Pl. IV, fig. 10). Siphonal plumes fairly large, with plumose hairs; sub-siphonal plumes similarly haired, and also large. Anal plume consists of a simple triple hair of moderate length.

The siphon is nearly two-thirds of the length of the abdomen—six units to ten; it is thin and tapering, a little more than eight times the base in length; the spines run for just over one-sixth of the length; there are some minute hairs which appear to be variable; the valves are small (Pl. IV, fig. 10).

Anal segment long, a little less than twice its base in length; papillæ thin and pointed, compressed at base, unequal; the longer are slightly shorter than the segment. There are long hairs on the dorsal edge. The beard is inserted on a shield right in the mouth of the segment, and is longer than the papillæ.

Larva 4 mm. long, siphon $1\frac{1}{3}$ mm.

Pupa.

The pupa has a comparatively small body, long trumpets, and more hairs on the segments than usual: the plume on the seventh segment is thick but of only simple or subplumose hairs; the plates are without any ciliation at their edges (Pl. IV, fig. 11).

Length of thorax $1\frac{1}{2}$ mm.

Described from five larvæ and one pupa.

[Egg-raft found upon water in a tin can containing vegetable matter, in September. The rafts were sharp-pointed and composed of 80 to 120 small black cylindrical eggs.—W. M. G.]

19. **Culex dissimilis.** Theo.

Larva.

Head of fair size, light in colour. Antennæ like that of *Culex albovirgatus*, Graham, with a big plume and branched hairs at the tip. The mouth-parts have been dissected out and are separately described in the explanation of the plate (Pl. IV, figs. 2–9). Plumes on the face large, and with the secondary pubescence rather long.

Thorax marked, with all the plumes big and with very plumose hairs.

Plumes on abdomen of moderate size, hairs plumose; on segments 3–7 are single long hairs, which are almost subplumose. Combs difficult to make out, but appearing as three rows of equal short oblong scales, about 30 in number, of which the anterior are the closest together (Pl. III, figs. 18 & 19). The plumes at the base of the siphon are very closely plumose, and an unusual feature is that the anal plume is also plumose, but in a much less degree.

The siphon is stout and tapers; it is less than one-half the length of the abdomen and is four times as long as its own base, being slightly swollen above the latter; there are no spines at the base, a space is bare for about $\frac{1}{6}$ of the length, then four short spines which run to about $\frac{1}{3}$; then there are some long subplumose hairs; at the distal end of the middle third is a short triple hair; and on the lateral surfaces, nearly in the middle, are single long hairs; valves small (Pl. III, fig. 17).

The anal segment is narrow at the base, and carries stout blunt papillæ, the dorsal being about double the length of the ventral, which are nearly the same length as the segment; there are four long simple hairs on the dorsal edge; the beard is short and inserted at the end. There are single lateral hairs in the middle of the posterior edge of the segment which are slightly plumose, like the hairs on the abdomen; the others are, as usual, simple.

Length of larva 5 mm., siphon $1\frac{1}{2}$ mm.

Pupa.

The pupa is rather light in colour; the trumpets are moderately short, and have a slight cloud at their ends, being darker at the base; there are some single long hairs on the segments of the abdomen which are subplumose—an usual condition in the pupæ (Pl. IV, fig. 1).

Length of thorax 2 mm.

Described from four larvæ and four pupæ.

[Larvæ found in July in a barrel standing in a water-hole. The barrel was used by the natives as a washtub and contained very foul, opaque, stinking water covered with froth.—W. M. G.]

20. **Culex albovirgatus**, Graham.

Larva.

Head rather narrow, nine units, as compared with thirteen units of thorax. Antennæ long: at two-thirds from base is a fan-shaped plume of plumose hairs; at the end, two short spines and three branched hairs; a marked constriction at the plume; the lower part is covered with dark short sharp hairs, which also show on the outer edge (Pl. I, fig. 1). All the mouth-parts very hairy. The face is furnished with the usual plumes, six in

number, consisting of compound hairs of about six plumose hairs or branches (Pl. I, fig. 2).

Thorax fairly large and differentiated, with the segments obvious; with the usual series of single, double, and triple plumose hairs along its dorsal anterior edge, which reach forward over the head; the anterior segment bears lateral plumes, and on each of its upper sides one of those minute stellate hairs, which seem to represent an early stage of the "palmate hairs" in *Anopheles* (Pl. I, fig. 3). The middle and posterior segments bear some long dorsal single plumose hairs and two pairs of long lateral plumes.

The first three and the eighth segments of the abdomen are shorter than the others. The first two carry lateral plumes, the upper consisting of two and the lower of four and three plumose hairs. The other segments carry shorter single hairs of various lengths, the longer subplumose and the short simple. The third to the seventh segments carry minute stellate hairs on the dorsal side. The sub-siphonal plumes are moderate in size, as are also the siphonal; the hairs of both are very plumose; the plume at the base of the anal segment consists of 3–4 subplumose hairs. The combs (on the eighth segment) are difficult to make out, but appear, anteriorly, as a number of minute scales in a long and regular row, followed by one or two irregular rows of bigger scales; they show best if the transparent membrane between the eighth and anal segments can be brought into view: the appearance of the scales is peculiar and I think there are at least 40, but I found it impossible to get the whole process into one focus of even low-power objectives, without dissecting the larva.

The siphon is thick and suboval; it is mostly without any colour or marks, and the length is not quite four times that of the base (Pl. I, fig. 4). The spines do not begin at the base, but after an interval which is $\frac{1}{7}$ of the length of the siphon; they are fairly long, but are only three or four in number. They are immediately followed by a pair of long hairs, just before the middle, and midway between these and the end is another pair placed transversely, and following these a short triple hair (all these spines, hairs and triple hairs are symmetrically paired).

The anal segment, at its greatest chitinous length, is less than $\frac{1}{3}$ of that of the siphon. The papillæ, though hyaline, bear some markings; they are unequal and fairly long; two are double the length of the segment, and two (the dorsal) about a third longer—all fairly stout and with moderately pointed ends. At the dorsal edge of the segment are four long hairs which are longer than the longer papillæ. There appear to be no long hairs on the ventral edge, but there is a compound plume (ventral beard) which springs from six bases, and is longest at its posterior portion, where it about equals in length the shorter papillæ. It will be noticed that all the hairs on the anal segment are simple, and this is the prevailing condition; they are more liable to injury and denudation than those on any other part.

Length of larva (without siphon) just over 5 mm., length of siphon nearly 2 mm.

PUPA.

Rather small, with moderate trumpets, which have a slight indentation at the mouth. At the base of the thorax is a brush of short hairs (not a plume), and a few longer hairs are more anteriorly placed; there are also some compound hairs at the spot where the neck shows through the sac. These are the appearances seen under the compound microscope with an absolutely rigid angle of vision. Focussing down it will be seen that the brushes and hairs are double, but I think it will be best to keep to one focus in describing the pupæ.

On the edge of the first segment (or what appears to be the first segment) are paired plumes of stellate hairs, and all the segments are haired at their edges; the seventh segment has a pair of small plumes of branched or subplumose hairs on the posterior angles (Pl. I, figs. 5 & 6). The anal plates are of the usual subcircular shape.

The thorax at its longest part is under 2 mm.

Described from eight larvæ and five pupæ.

[Larvæ found in an earthen fetich-pot placed upon a small mound outside a native village, in May. The pot contained clear brownish water above a deep layer of mud, decayed leaves and small twigs.—W. M. G.]

21. **Culex aquilus**, Graham.

LARVA.

Head large in proportion to the thorax, quite as broad in its widest part. Colour fairly light. Antennæ like those of *C. alborirgatus*, Graham, except that the distal hairs are simple and not branched; the mouth-parts are very bushily haired, especially the brush. Plumes on face much denuded in four larvæ examined, but probably short and not conspicuous.

Thorax well differentiated from abdomen, with the normal plumes and frontal hairs.

Abdomen not conspicuously hairy, but on the fourth and sixth segments long single subplumose hairs are present in two of the four specimens. Small stellate hairs were seen on several segments, but were not sufficiently symmetrical to be described as characters. Comb rather larger, comprising four rows of scales reaching from the base of the siphon to the middle of the eighth segment and consisting of about 25–30 scales, of which the posterior are the largest (Pl. I, fig. 14). The sub-siphonal plumes are well developed, and formed of the usual plumose hairs. The anal plume consists of three simple hairs.

The siphon is fairly long and thin, being two-thirds of the length of the abdomen and 9–10 times as long as its base. The spines are fairly long and

close to each other; increasing in size as they leave the base, they run for one-quarter of the length of the siphon (Pl. I, fig. 13). There are about four pairs of double hairs showing on the ventral surface, and about the same on the dorsal, and the valves are fairly large.

The anal segment is moderately long, the proportion of the length to the basal width being as 7 to 4. The papillæ are unequal in length, two being about 14 units and the others about 25; they are hyaline and pointed. There are sockets for probably long hairs on the dorsal edge and a moderate beard on the ventral side, but the specimens have suffered considerable denudation.

Larva $3\frac{1}{2}$ mm. in length, siphon $1\frac{3}{4}$ mm.

Described from four larvæ; pupa unknown.

[Larvæ found in borrow-pits along the course of the railway, early in June.—W. M. G.]

22. **Culex caliginosus**, Graham.

LARVA.

Head moderately large, dark, not so wide as thorax. Antennæ rather thin: plume small and of simple hairs (Pl. II, fig. 14). Maxillæ very hairy; brushes not so hairy as usual. The plumes on the face are of moderate size, of stiff straight simple hairs.

The thorax calls for no remark, except that the plumes on the sides are rather short, consisting of straight hairs, but they are so covered with parasitic growths, that I cannot be sure if they are plumose or not.

Plumes on the first and second segments of the abdomen comparatively short, and on the remaining segments shorter still, and simple. Comb consisting of a single row of at least ten scales; seen from a semi-dorsal view they are claw-like in appearance (Pl. II, fig. 15). The sub-siphonal plumes consist of simple hairs, each straight and not tapering; the siphonal ones insignificant.

Siphon rather short and stout, its length, compared with that of the abdomen, being as 5 to 13; rather less than 4 times as long as the base, perhaps $3\frac{1}{2}$. The spines begin at the base with four small serrate dark ones close together, finishing with a fifth larger one*; then come at intervals three large ones with lighter bases, which extend slightly beyond the middle; beyond them on each side is a small stellate hair. It is as well to say that the spines are difficult to see at the base; the larger ones show quite easily, but a great deal of manipulation is necessary to get the siphon lying quite flat in the trough (Pl. II, fig. 13).

* These are the appearances with low powers. I have made a preparation of this siphon and find a very minute one below those mentioned; the serrations on the uppermost spine are more marked than those figured on Pl. II, fig. 12.

The anal segment is moderately long, with very long thin tapering papillæ of not quite equal size; they are about three times the length of the segment. This has a plume (very unusual) and two long hairs on its dorsal edge, and is heavily bearded all along its ventral surface; all these hairs are simple.

Length of larva 4½ mm., siphon over 1 mm.

Pupa.

The pupa is of fair size, with short trumpets and rather broad anal plates; the plumes at the ends of the seventh segment are small and apparently (with 60 diameters) of simple hairs (Pl. III, fig. 1).

Length of thorax 1½ mm.

Described from two larvæ and three pupæ.

[Larvæ found in borrow-pits early in June.—W. M. G.]

23. **Culex lividocostalis**, Graham.

Larva.

Head of moderate size, slightly dark in colour. Antennæ with a large plume of plumose hairs and simple hairs at the end. Plumes on face long, but of few hairs; the four central ones consist of two hairs each, and the outer of six hairs, all plumose.

Thorax well marked, with normal plumes.

Abdomen with but few long hairs, and those simple or subplumose, but a number of minute stellate hairs are to be found on the ventral edges of the segments, and also higher up on the sides. The comb is large, consisting of very small "comma" scales, anteriorly in a long row, and then forming three scattered rows of longer scales; under favourable conditions it can be seen that the larger carry some lighter structure at their end.

Siphon thin, moderately long, about one-third (9 to 24) the length of the abdomen; eight times as long as the base; about 12 spines, which are distinctly serrate on their edges, run for nearly a third of the length (Pl. IV, figs. 12 & 13).

Anal segment fairly long, with two of the papillæ about as long as the segment, and two perceptibly shorter; it carries long hairs on the dorsal edge, with a beard ventrally on the distal third, which is much denuded in the specimens; there are single simple lateral hairs on the upper part.

Larva 4½ mm. long, siphon 1½ mm.

Pupa.

The pupa has fairly long trumpets which are darker at the ends and base; it has rather more hairs on the abdomen, which are mostly stellate and always simple, as are the two plumes on the sixth and seventh segments; there are very minute hairs on the ribs of the anal plates (Pl. IV, fig. 14).

Length of thorax, less than 2 mm.

Described from two larvæ and two pupæ.

[Larvæ found in some water that had collected in an empty Portland cement barrel in July.—W. M. G.]

24. **Culex pullatus**, Graham.

LARVA.

Head fairly broad: at the eyes, nearly as broad as the thorax. Antenna with large plume of plumose hairs; the distal joint black, and carrying four strong simple hairs and a short spine at its tip; the spine is very liable to injury. Mouth-parts very hairy. Face with usual plumes.

Thorax much the same as in *Culex albovirgatus*, Graham, but no stellate hairs have been detected.

Abdomen rather long, with the third to the sixth segments carrying short lateral plumes of simple hairs (4 to 6). Sub-siphonal plumes rather large, and the root rather prominent: siphonal plumes also well marked. Anal plume consisting of few hairs, and these appear simple (difficult to see). Combs easily seen as dark scales, sixteen in number, the four posterior in a row and longer than the others.

Siphon nearly as long as the abdomen, very long and tapering, nearly thirteen times as long as the base. The spines are comparatively rather long at the base, and run for $\frac{1}{8}$ of the length, but are few and scattered. The siphon is otherwise bare, except for very minute pubescence.

Anal segment longer than broad, in the proportion of 20 to 17; papillæ equal in size, hyaline, slightly longer than the segment, and with sharply pointed ends. Long plumose hairs are present on the dorsal edge with the sockets much chitinised; the sockets of the ventral beard are also very evident; the latter is about as long as the papillæ (Pl. I, fig. 7).

Length of larva 4 mm., siphon $3\frac{1}{2}$ mm.

Several larvæ were covered with a parasitic growth, vorticellæ, etc.

PUPA.

Furnished with long thin trumpets, which, like many others, are darker at the base; hairs at base of thorax similar to those of *Culex albovirgatus*. Constriction at head marked in some pupæ. The small plume on the last segment consists of plumose, not branched hairs (Pl. I, figs. 8 & 9). There is also a plume (simple) on the sixth segment.

Thorax of pupæ under 2 mm. at greatest length.

Described from seven larvæ and four pupæ.

[Larvæ found in borrow-pits along the course of the railway. The species is plentiful from June to the middle of August. The colour varies considerably.—W. M. G.]

25. **Megaculex pincerna**, Graham.

Larva.

Dark, larger species.

Head nearly as large as thorax, very dark. Antennæ curved and peculiar, the distal joint going off at an angle ; the base is dark, but they become lighter at the end : about $\frac{3}{5}$ from the base a fan-plume of very plumose hairs is inserted : at the base of the distal joint is a long spine and the joint itself carries two spines, a long and short one (Pl. II, fig. 5). The brushes with stiff long hairs, rather prominent. Plumes on the face large and of very plumose hairs.

The thorax is small, but very markedly plumed.

The abdomen has some long single hairs (subplumose) as well as short stellate plumes of single hairs (Pl. II, fig. 8), two of the latter on each side of a segment, placed transversely. The comb consists of a single row of 7–8 long scales.

The siphon is about half the length of the abdomen and only tapers slightly ; it is four times the length of the base. It is remarkable for the apparent absence of the spines, which are very minute and atrophied ; there are lateral plumes, inserted about the middle ; the valves are large (Pl. I, fig. 7).

The anal segment is long, and is also singular, as it is longer on its dorsal side and has a rough surface ; minute serrations can be seen with careful focussing on the dorsal side, and there are some minute spines on the edges of the sides (Pl. II, fig. 9). The papillæ are thin, pointed, equal, and of about the same length as the segment ; there are long hairs on the dorsal edge and the beard which is inserted at the end of the segment is thin, but much longer than the papillæ (Pl. II, fig. 9) ; all the hairs are simple.

Length of larva $3\frac{1}{2}$ mm.

Pupa.

The pupa is very dark and has remarkably long, thin trumpets ; the anal plates are also peculiar, as they are of unusual shape and dark, and the edges are minutely serrate. The small plumes at the ends of the seventh segment appear to be absent ; but as I had only one specimen, which from its curves was exceedingly difficult to manipulate, I am not sure (Pl. II, figs. 6, 6 *a*).

Length of thorax 2 mm., of trumpet $1\frac{1}{2}$ mm.

Described from two larvæ and one pupa.

Dr. Graham tells me that there is a white spot on the anal plate, but the action of the formalin has quite obliterated it in this specimen ; he states that it is a very distinctive feature in the living pupa, or in newly killed specimens.

[Larvæ found in borrow-pits early in June.—W. M. G.]

26. **Pectinopalpus fuscus**, Theo. ? (I) *.

Larva.

Head as broad as thorax, light in colour. Antennæ with a big plume, the fine secondary hairs of which are longer than the normal ; there are 2–3 long simple hairs at the end ; the mouth-parts are very hairy, and the maxillæ are marked and carry long hairs at their ends ; these are best seen on the lateral view (Pl. II, fig. 10). Face with two single or triple hairs in the middle, two triple ones flanking these and two plumes of six hairs on the outside ; all the hairs plumose (Pl. II, fig. 11). Besides these, there is a row of minute stellate hairs between the eyes, flanked by short plumes, all very difficult to see.

The thorax is very hairy, with long plumose hairs of normal arrangement.

The abdomen calls for no special remark. The comb is very difficult to make out, but in a favourable specimen it is seen to be rather away from the base of the siphon (or appears so from the angle of vision) and to have some particularly long scales on the posterior part.

The siphon is nearly as long as the abdomen and is ten times as long as its own base ; the spines, which are weak and colourless, run to a little over a sixth of the length ; a higher magnification shows them to be serrated (Pl. II, fig. 12) ; there are also short triple hairs on the surface, rather liable to be rubbed off (Pl. II, fig. 10).

The anal segment is distinctly long, about the same length as the seventh and eighth segments together ; the papillæ are unequal, and hyaline ; the comparative length of the longer pair to that of the segment is as 3 to 2, and the shorter pair are not quite so long as the anal segment ; they are moderately pointed. The dorsal edge bears long hairs and some shorter ones ; the ventral beard is as long as the longer papillæ, and covers the distal third of the segment.

The larva is 3 mm. long, the siphon $1\frac{2}{3}$ mm.

Described from three specimens ; pupa unknown.

[Larvæ found in borrow-pits along the course of the railway, early in June.—W. M. G.]

27. **Pectinopalpus fuscus**, Theo. ? (II).

Larva.

Resembles the last described larva in some respects, but is stouter and longer. It has less pronounced maxillæ.

* From this and the succeeding species of larva only a single imago was bred, and owing to an unfortunate confusion it is not yet possible to say which of the two is the true larva of *P. fuscus*.—Ed.

The siphon is proportionately short, its length, as compared with the abdomen, being as 2 to 3 ; it is over ten times as long as its own base. The spines are darker and stronger, running for only $\frac{1}{7}$ of the length ; the base of the siphon is narrower, and it is generally less stout.

The anal papillæ are all equal, much pointed and slightly yellow in colour, not hyaline. They equal the segment in length. The ventral beard is longer than the papillæ.

Length of larva $3\frac{1}{4}$ mm., siphon $1\frac{1}{2}$ mm.

Described from a single specimen ; pupa unknown.

28. **Myxosquamus paludosus**, Graham.

Larva.

Head rather small, not dark, but darker than some species. Antennæ very long and thin, with a small plume of four (?) simple hairs, inserted distinctly below the middle, with short and simple hairs on the end (Pl. V, fig. 16). Brush very large. The face carries long plumes of subplumose hairs. Eyes large, and with the pigment spot not separated, but adhering to them.

Thorax with the hairs of the anterior edge short on the sides, and only subplumose—the middle ones are denuded ; the side plumes, however, are fairly long and of quite plumose hairs.

Abdomen with few hairs or plumes, and those are inconspicuous or normal. The comb appears as a patch of three to four rows of minute scales. Sub-siphonal plumes small : only plumose at the base of the hairs. Anal plume of fine simple hairs.

Siphon rather short, its length, as compared with that of the abdomen, being as 7 to 30 ; $3\frac{1}{2}$ times as long as its base ; the spines are many and close together, and run for $\frac{3}{7}$ of the length ; single hairs are present laterally, but much liable to denudation (Pl. V, fig. 15).

The anal segment is short ; the papillæ pointed, unequal, not hyaline, dirty in colour, with the longer pair only slightly longer than the segment ; there is a tuft of hairs, and other longer hairs on the dorsal edge : ventral beard thick, on about eleven black roots, considerably longer than the papillæ, and coming well over the ventral edge at the end.

Larva nearly 6 mm. long.

Pupa.

With short trumpets, without plumes on the sixth segment. Anal plates run at a sharper curve from the ribs, and no spine is present at the end of a rib (Pl. V, figs. 17 & 18).

Length of thorax fully 2 mm.

Described from one larva and one pupa.

[Larva and pupa found in the water of a crab-hole at the edge of the Ebuli-putta lagoon, early in September. The crab-hole communicated below ground with the lagoon, but no larva was found in the adjacent water of the lagoon, their existence being perhaps prevented by the presence of small fish. These fish were absent from the crab-hole.—W. M. G.]

29. **Uranotænia balfouri**, Theo.

LARVA.

These are small, very dark and rather elongate larvæ, with dark heads of peculiar shape.

The antennæ are small and without plumes: brush moderate; the face has four characteristic thick hairs and a plume on each side.

The thorax has the usual hairs on the anterior edge, and pronounced plumes on the sides; it can just be seen that the hairs are plumose. On the ventral side are two peculiar "star hairs" on each of the posterior angles (Pl. II, fig. 4).

From the second segment there are short plumes of stellate simple hairs, two on each side of the segment, one above the other, which give a fairly hairy appearance to the abdomen. The usual plumes on the eighth segment are present. Seen with a magnification of 60 diameters the comb appears as a row of 6–8 dark squares; seen with about double that magnification, it appears as a single row of six spines with double or split bases (Pl. I, fig. 19).

The siphon is short, being less than one half the length of the abdomen; it measures $3\frac{1}{2}$ times its own base, and does not taper to the valves, which are large; the spines are small, numerous and regularly disposed, they run for $\frac{2}{5}$ of the length from the base; in the middle of the ventral side are large lateral plumes; its structure is a very characteristic one (Pl. II, fig. 1).

The anal segment is long, with shorter papillæ; there are many long hairs on the dorsal edge, and a few on the ventral; no beard, but some long hairs on the edge and a plume on the ventral side.

All the hairs on this larva are either simple, or much less plumose than in the others.

Length of larva less than 3 mm.

PUPA.

This is also small, and has some hairs near the trumpets, which are only occasionally present. The shape of the anal plates is peculiar, being more knife-like than usual (Pl. II, figs. 2 & 3).

Thorax of pupa 1 mm. long.

Described from four larvæ and three pupæ.

[Larvæ found in borrow-pits along the side of the railway from June to the middle of July. In the resting position the larvæ lie almost horizontally.—W. M. G.]

EXPLANATION OF PLATE I.

Fig. 1. Antenna of larva of *Culex albovirgatus*, Graham.

2. One of the plumes on the face of the same larva to show the plumose character of the hairs.

3. Small stellate hair from the thorax of the same larva; unusually bushy and strong; the majority of small stellate hairs are like those figured on the abdomen of *Culex guiarti*, Blanch. (Pl. VII, fig. 4).

4. Seventh, eighth and anal segments of the same larva; lateral view (right side), showing the characters on the posterior portion of the larva.
   - *a*. Siphon or respiratory tube.
   - *b*. Anal segment.
   - *c*. Spines of the siphon, the "pectens" of Felt.
   - *d*. Comb.
   - *e*. Siphonal plume.
   - *f*. Sub-siphonal plume.
   - *g*. Anal plume.
   - *h*. Hairs on dorsal edge of anal segment.
   - *i*. Ventral beard of anal segment.
   - *k*. Papillæ, or anal papillæ.
   - *m*. Eighth segment.

5. Pupa of *Culex albovirgatus*, Graham; lateral view, with the animal lying on its side in the trough.
   - *a*. Trumpets or respiratory trumpets.
   - *b*. Anal plates or fins.
   - *c*. Seventh segment bearing plumes.

6. Portions of the seventh segment and an anal plate of the same pupa, more magnified, to show the plume of branched hairs: ventral view.

7. The anal segment and surrounding parts of larva of *Culex pullatus*, Graham; lateral view (left side), and more highly magnified than fig. 4; only a small portion of the siphon (which is very long) is shown.

8. Pupa of *Culex pullatus*, Graham; lateral view.

9. Portion of seventh segment of the same pupa, seen dorsally, to show the small plume of plumose hairs.

10. Siphon of the larva of *Culiciomyia freetownensis*, Theo., lateral view; the ventral side is on the right.

11. Pupa of *Culiciomyia freetownensis*, Theo., lateral view.

12. The same pupa seen from the dorsal side with the head bent quite under; the sockets of the frontal setæ give an idea of the angle at which the animal is seen. To show the real distribution of the plumes and hairs, compared with the appearance seen through the microscope from a lateral view.

13. Siphon of the larva of *Culex aquilus*, Graham; half lateral view, showing both rows of spines.

14. Comb of the same larva, magnified about 60 diameters.

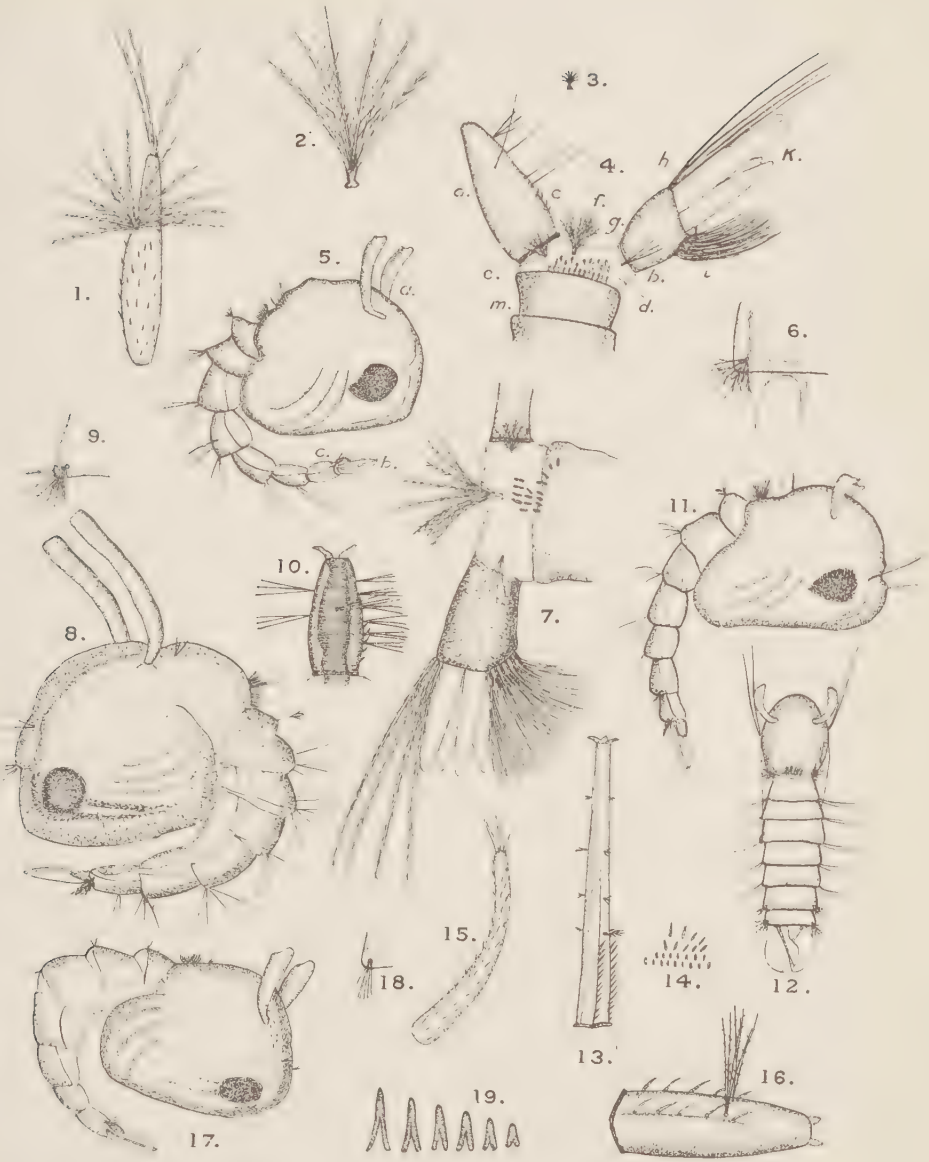
15. Antenna of the larva of *Ædimorphus punctothoracis*, Theo.

16. Siphon of the same larva, half lateral view.

17. Pupa of *Æ. punctothoracis*, lateral view.

18. Portion of the seventh segment of the same pupa, to show the small plume of simple hairs.

19. Comb of the larva of *Uranotænia balfouri*, Theo., as seen with low powers.



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WEST AFRICAN CULICIDAE.

EXPLANATION OF PLATE II.

Fig. 1. Siphon of the larva of *Uranotænia balfouri*, Theo.; lateral view, the ventral side on the left.

2. One of the anal plates of the pupa of *U. balfouri*.

3. Pupa of *U. balfouri*, lateral view.

4. The lower portion of the thorax of the larva of *U. balfouri*, seen on the ventral side to show the star hairs.

5. Antenna of the larva of *Megaculex pincerna*, Graham.

6. Pupa of *Megaculex pincerna*, lateral view.

6 *a*. One of the anal plates of the same pupa, enlarged. In life there is a conspicuous white spot on the plates, but all are bleached in the pupæ I have seen.

7. Siphon of the larva of *Megaculex pincerna*; lateral view, the ventral side on the right.

8. Third segment of the abdomen of the same larva, seen on the ventral side.

9. Anal segment of the same larva, lateral view.

10. Larva of *Pectinopalpus fuscus*, Theo. ? (I), seen on the ventral side, and with the siphon and anal segment twisted round so as to lie in the same plane as the rest of the abdomen. On the head: *a*, antenna; *b*, brush; *c*, eye; *d*, maxilla. On the thorax are found the usual plumes of plumose hairs. On the abdomen the first two segments also carry plumes of plumose hairs. The names of the parts on the eighth segment will be seen by comparing this figure with Pl. I, fig. 4.

11. Head and thorax of the same larva, showing the dorsal side. On the head: *d*, maxillary plume; *e*, labrum. On the thorax, the four frontal hairs and the four double hairs behind them are the "dorsal anterior plumes."

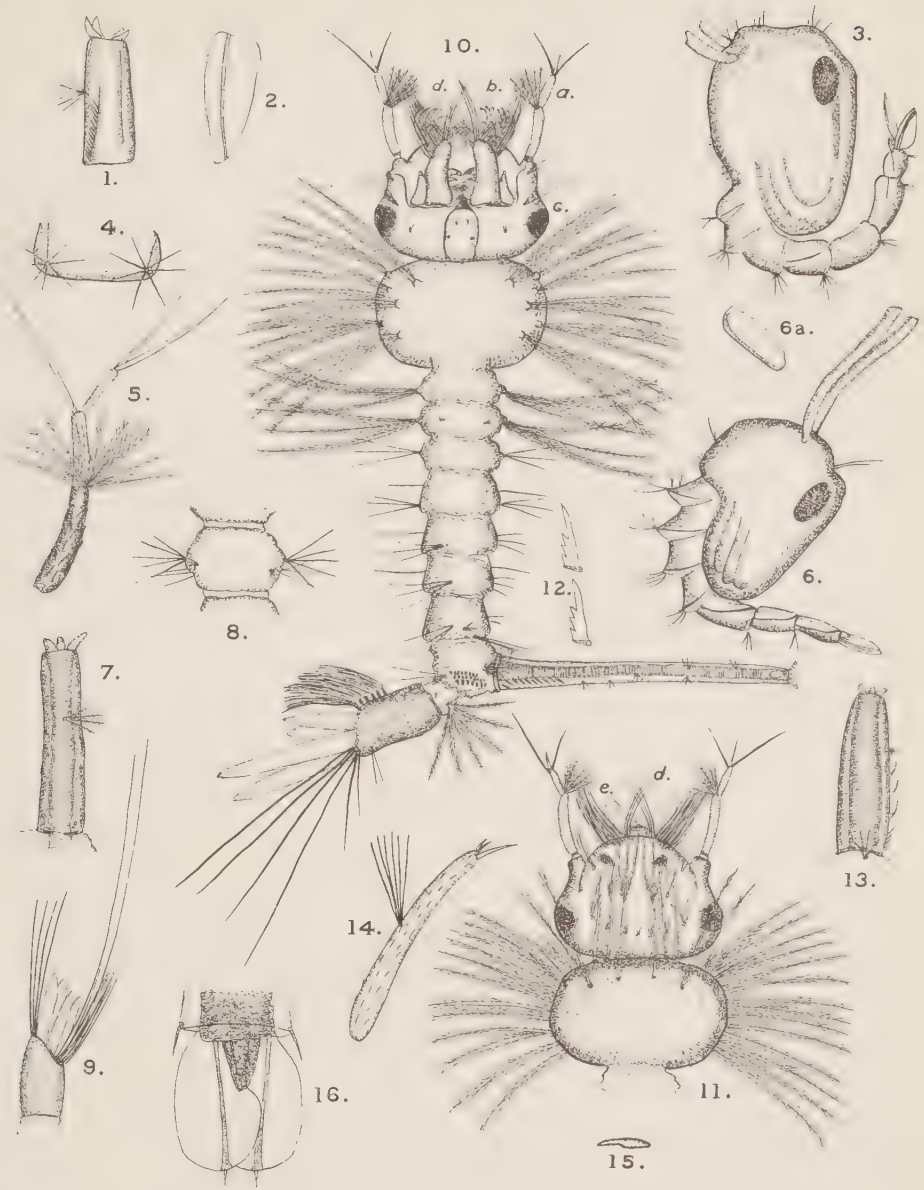
12. Two of the spines of the siphon of the same larva, highly magnified; they are very close to those on the larvæ of our British *Ædes cinereus*, Mg.

13. Siphon of the larva of *Culex caliginosus*, Graham; lateral view, the ventral side on the right; showing also one of the siphonal plumes with simple hairs.

14. Antenna of the same larva.

15. A side-view of a scale of the comb of the same larva, as seen with low powers, the animal being viewed from above.

16. Anal plates of the pupa of *Ædimorphus domesticus*, Theo., seen from the ventral side.



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EXPLANATION OF PLATE III.

Fig. 1. Pupa of *Culex caliginosus*, Graham, lateral view.

2. Siphon of the larva of *Ædimorphus domesticus*, Theo.; lateral view, the ventral side on the left.

3. First and second segments of the abdomen of the larva of *Stegomyia africana*, Theo.; dorsal view, showing the stellate and other hairs.

4. Siphon of the same larva; lateral view, the ventral side on the right.

5. Pupa of *Stegomyia africana*, Theo.; lateral view.

6. One of the anal plates of the same pupa, showing the unusual ciliation.

7. Larva of *Stegomyia africana*, Theo., dorsal view. (Immature form.)

8. Siphon of the same larva, more magnified and in a different position; lateral view, the ventral side being on the left.

9. Dorsal view of one of the comb-scales of the same larva.

10. Lateral view of the same scale, both highly magnified.

11. Pupa of *Stegomyia africana*, lateral view. (Bred from larvæ similar to fig. 7.)

12. Anal segment of the larva of *Culex tigripes*, Grandpré, var. *fusca*, Theo., seen from a half ventral view.

13. Siphon of the same larva; lateral view, the ventral side on the left.

14. The end of the same siphon, seen when the part was in a perpendicular position, and showing the stigmata of the spiracles and the valves and apodemes. *a*, spiracle; *b*, valve; *c*, apodeme; *e*, ventral side.

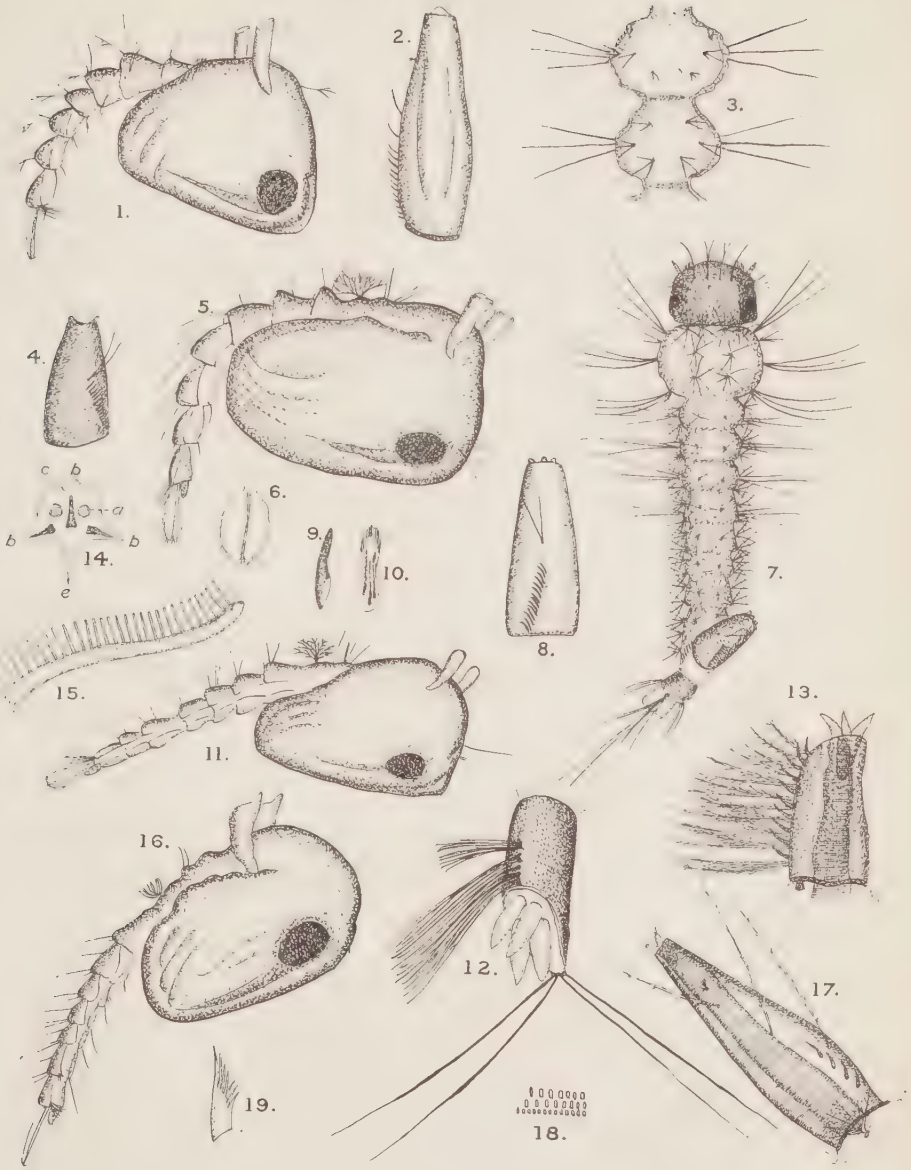
15. Part of a hair of the brush of the same larva, highly magnified.

16. Pupa of *C. tigripes*, var. *fusca*; lateral view.

17. Siphon of the larva of *Culex dissimilis*, Theo.; lateral view, the ventral side on the right.

18. Comb of the same larva.

19. A single scale of the same comb, highly magnified.



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EXPLANATION OF PLATE IV.

Fig. 1. Pupa of *Culex dissimilis*, Theo.; lateral view.

2. Labium, or inner mouth structure of the larva of *C. dissimilis*, dissected out, and seen with a magnification of 350 diameters.

3. "Under lip" (of Meinert) of the same larva, at the same scale of magnification.

4. Maxilla and palpus of the same larva, as seen with the same magnification, but drawn on a smaller scale.

5. Mandible of the same larva, seen and drawn in the same manner as the maxilla.

6. Structure under the labrum of the same larva, on the same scale as Figs. 2 and 3.

7. Labrum of the same larva, drawn on a slightly smaller scale than Fig. 6.

8. One of the brushes of the same larva, on a still lower scale: the comparative size of the parts is shown in Fig. 9. Muscle structure omitted, leaving the chitinous piece on which the hairs are socketed.

9. Diagram of the head of the same larva, showing the muscles that work the brushes, and the situation of the labrum; dorsal view, with all other structures omitted.

10. The siphon and anal segment of *Culex nigrocostalis*, Theo.; lateral view.

11. Pupa of *C. nigrocostalis*, lateral view.

12. Siphon of larva of *Culex lividocostalis*, Graham; lateral view, the ventral side to the left.

13. One of the spines of the same siphon more magnified.

14. Pupa of *C. lividocostalis*, lateral view.

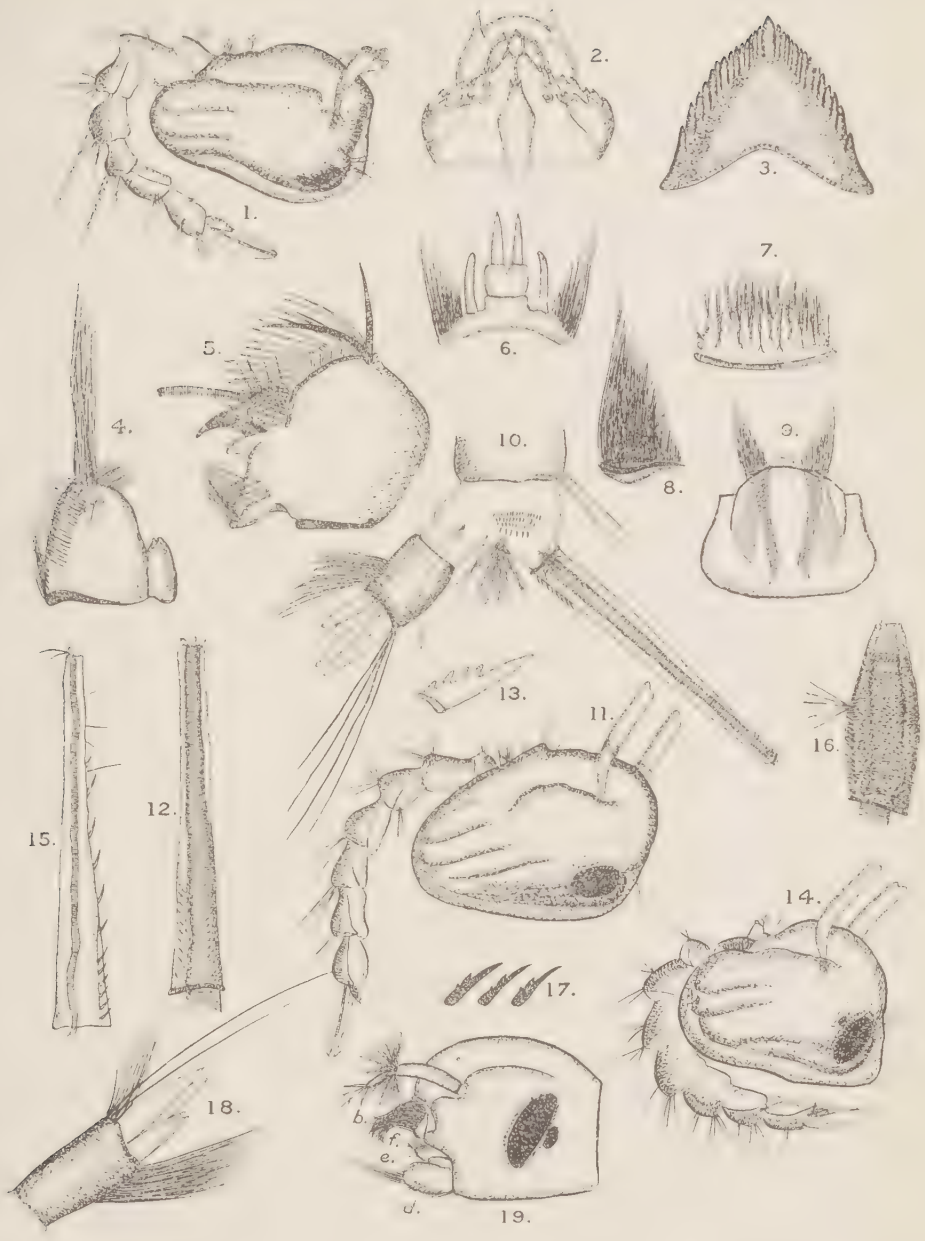
15. Siphon of the larva of *Culex pallidothoracis*, Theo.; lateral view, the ventral side to the right.

16. Siphon of the larva of *Scutomyia marshalli*, Theo.; lateral view, the ventral side to the left.

17. Spines on the same siphon more magnified.

18. Anal segment of the same larva; lateral view, the ventral beard below.

19. Head of the larva of *Culex dissimilis*, Theo.; lateral view, with all the plumes and hairs removed to show the relative situation of the mouth parts:—*b*, brush; *d*, maxilla; *e*, palpus; *f*, mandible.



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EXPLANATION OF PLATE V.

Fig. 1. One of a pair of ciliated structures in the pharynx of the larva of *Culex dissimilis*, Theo. The "weel" or "lobster-pot" arrangement of Professor Miall.

2. Siphon of the larva of *Culex duttoni*, Theo.; lateral view, ventral side on the left.

3. Antenna of the same larva.

4. Pupa of *C. duttoni*, lateral view.

5. Antenna of the larva of *Culiciomyia cinerea*, Theo.

6. Siphon of the same larva; lateral view, with the ventral side on the right.

7. Pupa of *Culiciomyia cinerea*, lateral view.

8. One of the anal plates of the same pupa, to show the characteristic shape.

9. Siphon of the larva of *Stegomyia apicoargentea*, Theo.; lateral view, the ventral side on the left.

10. One of the spines on the same siphon.

11. Dorsal view of the scales of the comb of the larva of *S. apicoargentea*.

12. Lateral view of the same scales, both diagrammatic.

13. Pupa of *S. apicoargentea*, lateral view.

14. Last two segments and anal plates of the same pupa; dorsal view.

15. Siphon of the larva of *Myxosquamus paludosus*, Graham; lateral view, the ventral side on the right.

16. Antenna of the same larva.

17. Pupa of *Myxosquamus paludosus*, lateral view.

18. Last two segments and anal plates of the same pupa.

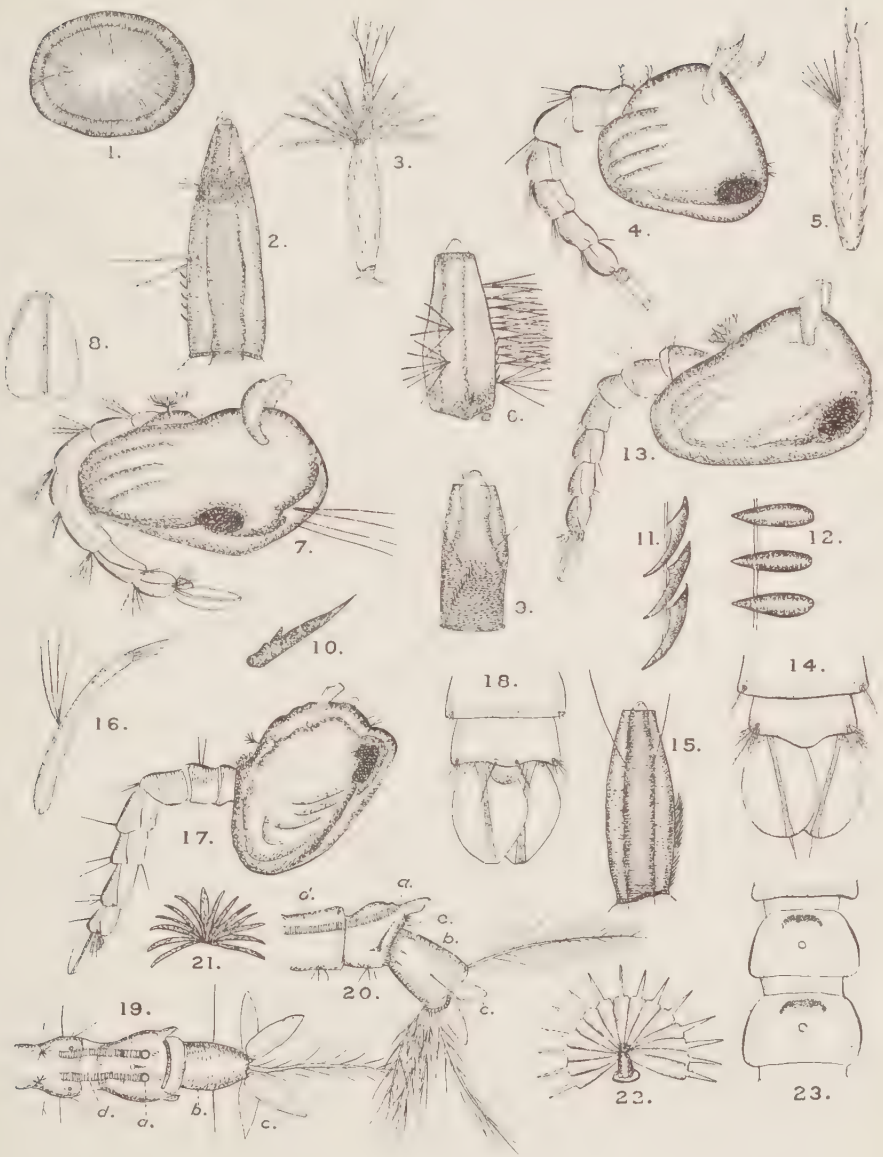
19. The seventh, eighth and anal abdominal segments of the larva of *Pyretophorus costalis*, Lw., to show the arrangement of these parts in the Anopheline larvæ, as they are seen from the dorsal view:—*a*, spiracles; *b*, anal segment; *c*, papillæ; *d*, respiratory trachea.

20. The same parts of the same larva, seen from the lateral view; the letters are the same, but *e* denotes the comb.

21. Modification of the palmate hair, seen on the first segment of the abdomen of the mature larva of *P. costalis*.

22. Palmate hair from the dorsum of the larva of *P. costalis*.

23. Pigment marks and central spot seen on the dorsal side of the abdominal segments of the mature larva of *P. costalis*.



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WEST AFRICAN CULICIDAE.

EXPLANATION OF PLATE VI.

Fig. 1. Thorax and head of the mature larva of *Pyretophorus costalis*, Lw., seen from the ventral side and showing the pattern mentioned in the text.

2. Antenna of the same larva.

3. A plume from the thorax of a $4\frac{1}{2}$ mm. larva of *P. costalis*; a typical "feathered hair."

4. Pupa of *P. costalis*, lateral view.

5. A trumpet of the same pupa, enlarged.

6. Anal plates of the same pupa; seen from the ventral side, to show the greater development of the ribs of the plates and the curious wavy hair at the end of the central processes.

7. Antenna of the larva of *Cellia pharoensis*, Theo.

8. Thorax of the same larva, seen from the ventral side, to show the simple hairs and the large bristle at their bases.

9. Comb of the same larva.

10. Palmate hairs on the abdomen of the (*b*) stage of the same larva. To show the relative proportion with the segments of the abdomen.

11. Pupa of *Cellia pharoensis*, Theo., lateral view.

12. Anal plates of the same pupa, seen from the ventral side and with the eighth segment removed.

13. Eighth segment of the same pupa removed from its position on the ventral side of the anal plates; to show the male "forcipes" enclosed.

14. Face plume of the larva of *Myzorhynchus mauritianus*, Theo., in the immature stage.

15. The same, on the mature, or more mature larva.

16. Palmate hairs on the same larva.

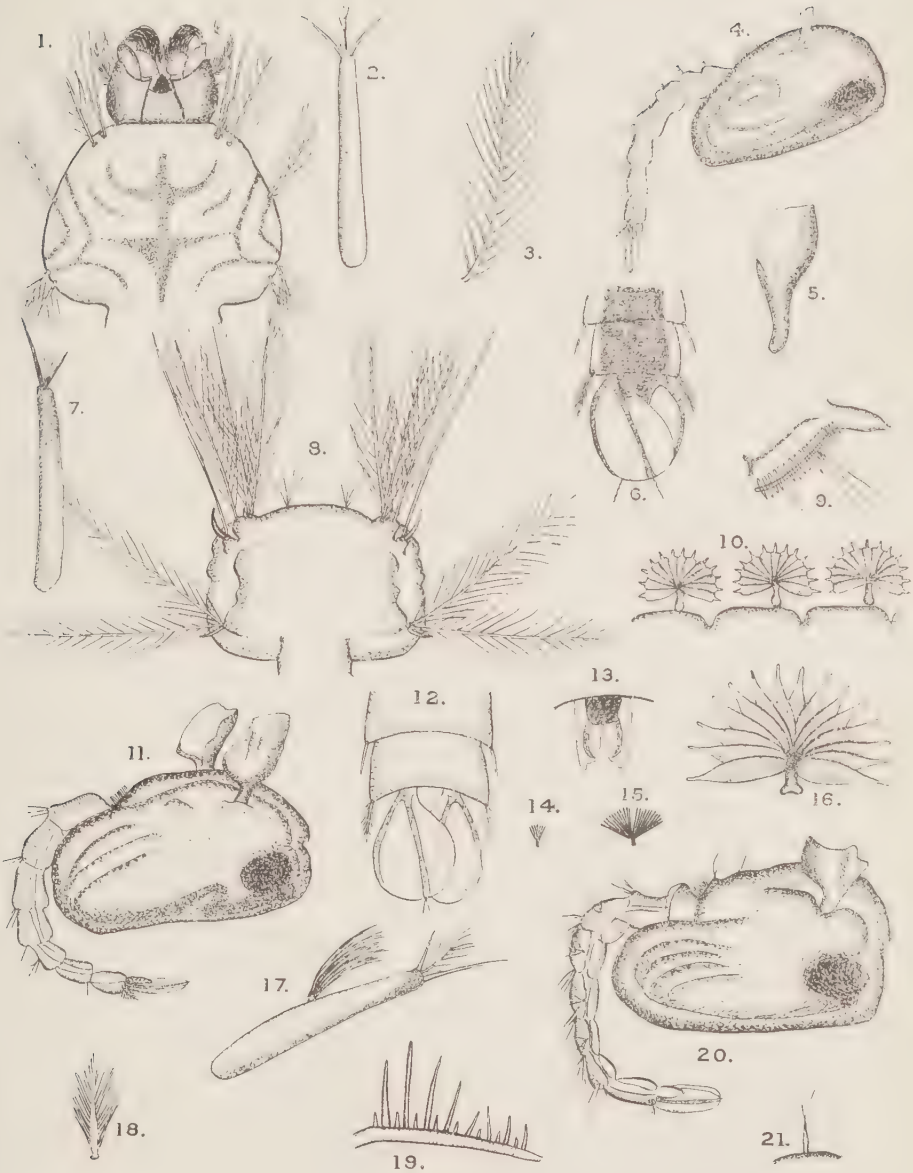
17. Antenna of the same larva.

18. Characteristic hairs on the dorsum of the thorax of the larva of *Cellia pharoensis*.

19. Comb of the larva of *M. mauritianus*.

20. Pupa of *M. mauritianus*, lateral view.

21. Characteristic double hair on the front (face) of the larva of *M. mauritianus*.



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EXPLANATION OF PLATE VII.

Fig. 1. Pupa of *Culex guiarti*, Blanch., lateral view.

2. Diagram of the ventral view of the trumpets, the pupa resting on them.

3. Anal plates and segments of the same pupa; dorsal view, to show the stellate hairs on the segments.

4. Larva of *Culex guiarti*, Blanch., dorsal view; the anterior dorsal plumes of the thorax are unusually long; the hairs on segments 3–7 of the abdomen are subplumose, and the siphon is longer than that of any other larva in the collection.

5. Anal plates of the pupa of *Culex quasigelidus*, Theo.; ventral view, showing the characteristic "cloud" or dark spot on the plates, and the plumes of branched hairs on the segments; the contained imago is a male, as can be seen by the "forcipes."

6. One of the trumpets of the same pupa.

7. Siphon of the larva of *Culex quasigelidus*, Theo.; lateral view, the ventral side on the left.

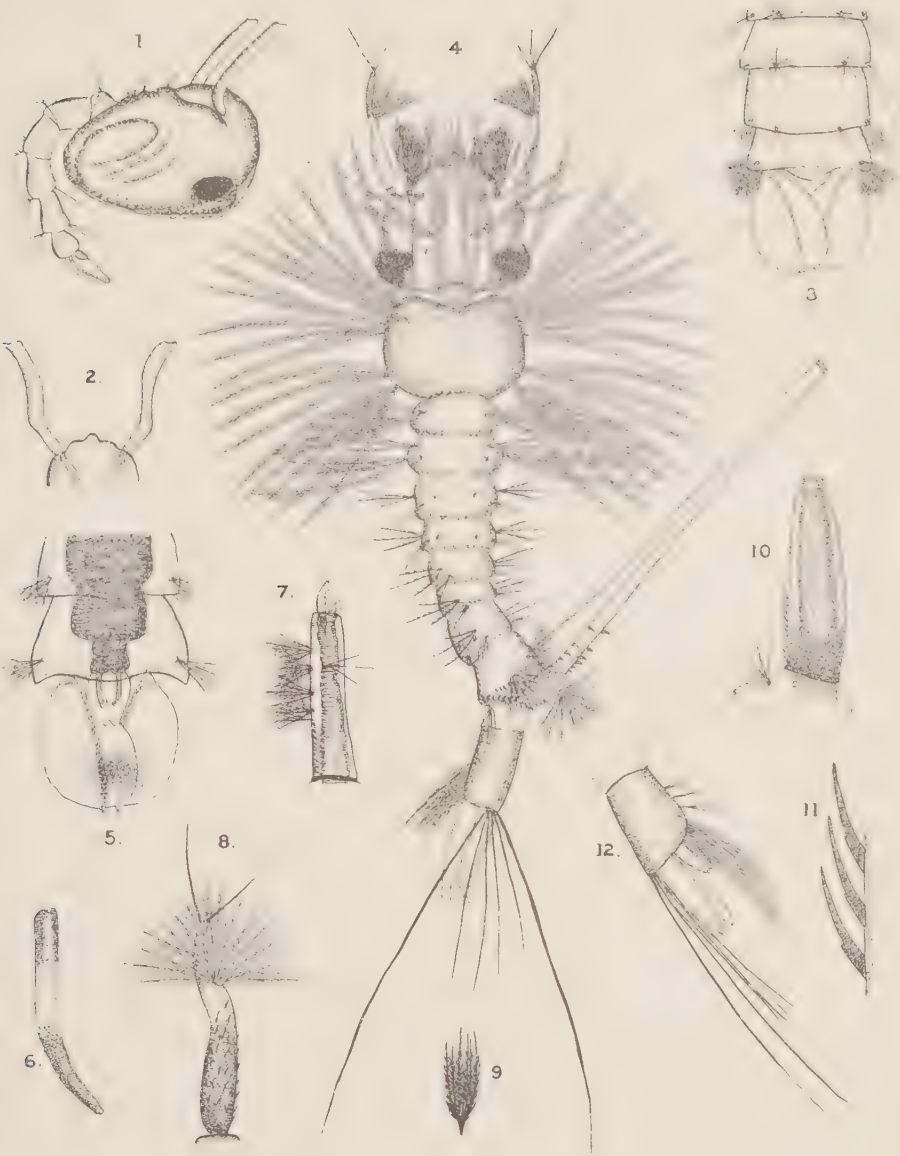
8. Antenna of the same larva.

9. Characteristic tuft near the base of the antenna of the same larva.

10. Siphon of the larva of *Stegomyia pollinctor*, Graham; lateral view, with the ventral side on the left and showing a sub-siphonal plume of simple hairs.

11. Spines on the siphon of the same larva.

12. Anal segment of the same larva, lateral view; the beard is denuded and is drawn as it exists on the solitary specimen examined; it probably covers the greater part of the ventral edge of the segment.



W. Wesché *del. ad nat.*

WEST AFRICAN CULICIDAE.

APPENDIX A.

The Study of Mosquito Larvæ.

By Dr. W. M. Graham.

To render the study of Mosquitoes practically useful to the sanitary officer, it should be made possible upon catching an adult mosquito anywhere, to say: this mosquito was bred in a water-butt, puddle, bamboo, empty tin, etc. It would thus be only necessary to find and destroy the breeding-place.

With the furtherance of this object in view, an attempt was made to collect all the larvæ of the locality, to rear them, to identify each with its imago, and to produce a photograph of each larva and pupa for future reference.

Difficulties were met with in rearing some species: either the larva died, or the eggs never hatched, but probably greater experience would enable artificial conditions to be sufficiently improved to allow of the rearing of these fastidious species.

The following were the methods adopted:—All local collections of water were searched for larvæ. A white enamelled steel soup-ladle, supplemented by a smaller spoon for narrow places, was found most suitable for catching larvæ.

The larvæ when caught were placed in glass tubes and subsequently carefully sorted. Those belonging to separate species were placed in separate wide-mouthed glass jars half filled with the water of the pool in which the larvæ had been found, a layer of the mud having first been placed upon the bottom of the jar. The top of the jar was covered with wire gauze, and where shade was the natural condition brown paper was rolled round the outside of the jar and secured by a rubber band. These precautions were sufficient to ensure the rearing of most larvæ; but in the case of eggs or of very young larvæ, they sometimes failed. Such failure is not to be wondered at when it is recognised that mosquito larvæ require a constant supply of special food, consisting usually of living fresh-water algæ, some species of which are very sensitive to changes in the density and chemical constituents of the water, or to the amount, and probably wave-length, of the light reaching them. The larvæ of *Pyretophorus costalis*, for example, are found breeding in water rendered partially opaque by suspended matter and containing motile algæ. The suspended matter is not removed by the centrifuge, but can be precipitated by an addition of 3 per cent. of common salt. On

precipitation the water becomes clear, the motile algæ become stationary, their transparent cytoplasm dissolves in the water, and the chloroplasts (chlorophyll corpuscles) fall to the bottom of the vessel. Then in the absence of their natural food, the larvæ in the jar become cannibalistic and destroy one another. In lesser concentration salt appears to inhibit the growth of very young larvæ, probably by diminishing the supply of food, but the development of fully-grown larvæ appears to be hastened in a hypertonic medium, and they pass into and through the pupal stage with unusual rapidity. From this it is evident that there are alternative methods available for the destruction of mosquito larvæ:

(1) Methods intended to destroy the larvæ.

(2) Methods intended to destroy the food of the larvæ.

Very little attention has been paid to the second method, though it is apparently worthy of further study. Unfortunately, any such investigation demands an exact knowledge of West African fresh-water algæ, a subject upon which very little information is at present available.

Whenever female mosquitoes full of eggs were caught, they were imprisoned in one of the glass jars, and in several cases egg-rafts were laid upon the water after a few days' captivity. Under such conditions, no eggs were laid by *Mansonia* females, and in most cases eggs so laid did not develop into larvæ.

It remains to describe the district in which the larvæ were found, and to explain some of the local conditions.

The country in the immediate vicinity of the Research Institute is flat grass-land covered with orchard-bush, with a few tall trees. There are several large water-holes close to the Institute, an extensive swamp about a mile to the east, and numerous borrow-pits and puddles along the course of the railway-line. The nearest water-hole is typical. In the dry season it measures about 30 × 40 yards, but during the rains it overflows its banks and extends over an area of 200 or 300 yards. The water-hole is used by the natives for bathing in and for washing clothes, but not as a drinking-supply. It contains cat-fish, but I have not observed any very small fish in it. A large herd of oxen is watered there twice daily, and the water at the edges is fouled with excrementitious matter, by the cattle.

In April the larva and pupa of *Pyretophorus costalis* were found in large numbers in the little bays along the edge of the water-hole. With the onset of the rains and the formation of road-puddles and the filling of borrow-pits, the numbers in the water-hole decreased, but were never wholly absent. They were always found where the water had been fouled by cattle, from March to November.

The larvæ of *Myzorhynchus mauritianus* and of *Cellia pharoensis* were also found here, but only during the months of June, July and August. The swamp about a mile behind the Institute was examined, but though the pools

appeared very suitable, no mosquito larvæ could be found in them; though I caught several female mosquitoes full of eggs in the fringe of bush round the swamp. The absence of larvæ may have been due to the activity of small silvery-spotted fish inhabiting the pools. The introduction of these small fish into the large water-holes, if successful, might diminish the number of mosquito larvæ; but probably the conditions in the large holes are unfavourable to the small fish, or they would long ago have occupied them naturally.

Borrow-pits exist along the course of the railway. During the rains they all contain water, during the dry season many of them become dry. Large numbers of larvæ were found in these pits.

Puddles are produced by the flooding of unlevel roads. Such collections of water are favourable for the growth of larvæ, and when the water is opaque Anopheline larvæ are almost always found.

Bamboos grow in clumps at the water-holes or in the bush beyond the villages. When cut, the stumps become filled with water during the rains, and if in a shady position retain water for long periods. In this water mosquito larvæ are often found. The bamboo should be cut through with a small saw below the internal disc and the contents examined in a suitable dish.

Fetich-pots are found at the entrances to most native villages. They are usually damaged native cooking-pots made of unglazed earthenware They are placed upon a mound at the entrance to a village, and contain water, vegetable débris and usually cowrie shells, and are often under the shade of trees. Mosquito larvæ are frequently found in their contents.

The rainy season usually begins in May and lasts till November. The temperature varies between 80° F. to 90° F. in the shade in the daytime, but falls lower at night in the middle of the rains.

APPENDIX B.

List of Mosquitoes found at Lagos, up to November 1909.

By Dr. W. M. Graham.

ANOPHELINÆ.

1. *Pyretophorus costalis*, Loew.
2. *Cellia pharoensis*, Theo.
3. *Myzorhynchus mauritianus*, Theo.
4. „ *strachani*, Theo.

MEGARHINÆ.

5. *Toxorhynchites marshalli*, Theo.

CULICINÆ.

6. *Stegomyia fasciata*, F.
7. „ *africana*, Theo.
8. „ *apicoargentea*, Theo.†
9. „ *pollinctor*, Graham*.
10. „ *luteocephala*, Newstead.
11. „ sp. nov.
12. „ sp. nov.
13. *Scutomyia marshalli*, Theo.
14. *Ædimorphus domesticus*, Theo.
15. „ *punctothoracis*, Theo.†
16. *Phagomyia irritans*, Theo.
17. *Culiciomyia freetownensis*, Theo.
18. „ *cinerea*, Theo.
19. *Culicelsa accraensis*, Theo.
20. *Culex duttoni*, Theo.
21. „ *tigripes*, Grandpré, var. *fusca*, Theo.
22. „ *chloroventer*, Theo.
23. „ *pallidothoracis*, Theo.†
24. „ *guiarti*, Blanch.
25. „ *quasigelidus*, Theo.
26. „ *durbanensis*, Theo.
27. *Culex nigrocostalis*, Theo.†
28. „ *dissimilis*, Theo.
29. „ *albovirgatus*, Graham.
30. „ *aquilus*, Graham.
31. „ *caliginosus*, Graham.
32. „ *lividocostalis*, Graham.
33. „ *pullatus*, Graham.
34. *Megaculex pincerna*, Graham.
35. *Tæniorhynchus violaceus*, Theo.
36. *Chrysoconops aurites*, Theo.
37. „ *annetti*, Theo.
38. *Pectinopalpus fuscus*, Theo.†
39. *Etorleptiomyia* sp. nov.
40. *Mansonia africana*, Theo.
41. „ *major*, Theo.
42. *Banksinella luteolateralis*, Theo.
43. „ *punctocostalis*, Theo.
44. *Melanoconion rima*, Theo.
45. *Myxosquamus paludosus*, Graham.

ÆDINÆ.

46. *Ædomyia squamipenna*, Theo.
47. *Verallina nigra*, Theo.

URANOTÆNINÆ.

48. *Uranotænia cæruleocephala*, Theo.
49. „ *pallidocephala*, Theo.
50. „ *balfouri*, Theo.
51. „ sp. nov.
52. *Mimomyia uniformis*, Theo.
53. „ sp. nov.

* For descriptions of all Dr. Graham's species, see Ann. Mag. Nat. Hist. (8) v, pp. 264–273.

† F. V. Theobald, Ann. Mag. Nat. Hist. (8) v, pp. 373–378.

NOTES ON THE BLOOD-SUCKING DIPTERA MET WITH IN EASTERN AND SOUTH-EASTERN ABYSSINIA.*

By R. E. DRAKE-BROCKMAN, M.R.C.S., L.R.C.P.

The highlands of Abyssinia are remarkably free from blood-sucking flies, if the Culicidæ, *Stomoxys*, and Hippoboscidæ are excepted.

Leaving the rail-head at Dirre Daua, and travelling along the Assobat Road to Addis Abeba, only one species of Muscidæ was met with, namely, *Stomoxys calcitrans*. These troublesome Diptera are very common in the Hawash Valley and around Mount Fantali, where they attack camels, horses, mules, cattle and human beings with equal vigour. They invariably attack the ankles of human beings; I have never known them to attack the hands or face. Here I obtained two specimens of a new species of *Tabanus* allied to *T. tæniola*; two others of this same species were also caught at Laga Hardin, within a few hours' march. In the Hawash Valley I also caught a solitary specimen of *Pangonia rüppellii*, and near Mount Fantali I found *Lyperosia minuta* very common. In this region the baggage animals were greatly troubled by *Hippobosca maculata*. Of the mosquitoes, there was one species of *Stegomyia* which has not yet been determined, *Pyretophorus costalis*, and *Grabhamia durbanensis*, both the latter from the base of Mount Fantali.

After leaving the valley of the Hawash, we travelled south over the great Arussi Plateau, and here *Stomoxys calcitrans* alone was found until the caravan descended into the valley of the River Wabi, one of the affluents of the Webi Shebeleh. The descent from Seru Abbas to the undulating valley known as Gamoji, through which flows the River Wabi, is about 3700 feet, and it was in this narrow belt of country between Seru Abbas and Mount Abunawas that a swarm of dipterous insects was encountered.

Here were represented one species of Tabanidæ, namely, *Corizoneura distincta*, one of *Stomoxys*, namely, the ubiquitous *S. calcitrans*, and two species of *Hæmatopota*, *H. mactans* and *H. pulchrithorax*. *Corizoneura distincta* was very common indeed, and a curious fact about this species was that, on leaving Seru Abbas (8350 feet), it was not met with until 6000 feet was reached; after that it was to be seen in hundreds all over Gamoji, and even up the slopes of Mount Abul Kassim to its very summit, 9000 feet high—Mount Abul Kassim standing in the middle of Gamoji. Owing to their presence in such troublesome numbers, this country is practically devoid of native villages at this time of the year. The bush seemed alive with them, but although they came hovering around human beings, I did not hear of anyone being bitten by them, while, on the other hand, the unfortunate camels, ponies,

* Received from the Colonial Office for publication.—Ed.

mules and cattle were so molested by their attentions during the heat of the day that they gave up all idea of grazing. The female alone attacks animals, the male obtaining necessary nourishment from the nectar of the wild flowers which were plentiful there in the month of October, following the rainy season. They start operations about 10 A.M., when the sun is high, and only continue to annoy while the sun is shining. If the sun is masked by clouds for even a short interval they slacken their attentions, and cease to bite altogether if the day be cloudy. Animals annoyed by them crowd together for protection, seeking the shade of the smallest bush or tree. This fly, together with other members of the same family, is known to the Somalis by the name of "Dug." They do not consider its bite dangerous to their stock, but they avoid the stretches of country which it frequents, as the animals, instead of grazing, spend their time keeping the flies off, and in consequence lose flesh rapidly.

The two species of *Hæmatopota* met with in this belt of country were caught on the banks of the River Daro, a tributary of the River Wabi. One I caught on my arm, and the remainder on the herd of bullocks which accompanied the caravan. I never saw any on the ponies, mules or camels—they seemed to prefer the cattle.

On leaving Gamoji we ascended to Gurri Dagono (6800 feet), and travelling in a south-easterly direction encountered no biting flies until Ginir was reached. Ginir is the great trading centre for Eastern Abyssinia, and here *Stomoxys calcitrans* abounded, and was very troublesome.

Here we left the Arussi country, and descended to the valley of the River Web, and then followed the river to its junction with the Ganale and the Dawa Rivers. At Odajida, on the River Dinnik, a tributary of the Web, I found *Hæmatopota maetans* on the cattle, but they were scarce. At Odhun, I found *Tabanus ditæniatus*, a species I had not hitherto met with; two or three settled on me while in my tent, but I hardly think they had any intention of feeding. I caught three more of this same species at Gebidi-labba-dehd, on the Web, and at Malka Sala, on the Dawa. It settles with an indistinct humming noise, which it makes while on the wing, and takes some time before it settles down to feed. It is well known to the Somalis by the name of "Bal ad," and is considered by them to be dangerous to stock—camels in particular suffering greatly from their onslaughts. Although human beings are frequently attacked by them, no ill effects seem to accrue. From Odhun to the junction of the Rivers Dawa and Ganale at Dolo (950 feet), and all along the banks of the former, the "Bal ad" is more or less common.

At Gebidi-labba-dehd, a species of *Tabanus*, *T. tæniola*, was caught, but it was rare, as only one specimen was obtained. At Dolo and at Malka Duggah, and, in fact, all along the Dawa River, *Tabanus morsitans* was very plentiful. At the former place another species of *Tabanus* was caught, but it has not yet been identified; only one specimen was obtained. This specimen is not unlike *T. morsitans*, both in appearance and habits. Along the Dawa River *T. morsitans* was very troublesome, the animals, especially the ponies, being

covered with them. *Hæmatopota mactans* was also very common along this river—more plentiful than I ever remember having seen it. At Malka Sala, one specimen of *Tabanus gratus* was caught; it settled on my arm and was about to start feeding.

Leaving the Dawa River for Muddo, the "Bal ad" was left behind, as it appears to cling to the banks of the river, never being found very far from them. Between Muddo and Banissa, *Pangonia*, in small numbers, were again found in the thick bush, but the *Hæmatopota* seem to have been left near the river.

Leaving Banissa, and passing in a north-westerly direction, the whole of Borana was traversed, and throughout this great cattle country no biting flies were met with, except the ubiquitous *Stomoxys*. Then north through Uraga, Sidamo, Western Arussi, and Gurage to the Abyssinian capital, Addis Abeba, biting flies were conspicuous by their absence, although a little to the west, down in the low-lying country on the shores of the chain of lakes in the Great Rift Valley, native reports said that there were biting flies in plenty.

It is highly probable that in the low-lying bush country, known as Gamoji, to the east of Lake Margherita, *Pangonia* are to be found, but the mountainous region to the west of the lake is, in all probability, free from them.

Tsetse Flies.

During the months of November and December, down the valleys of the Rivers Web and Dawa, I found tsetse flies conspicuous by their absence, and this is all the more remarkable, owing to the fact that in identically similar country, and living under somewhat similar conditions on the banks of the Juba River, a little farther south, both *Glossina longipennis* and *Glossina pallidipes* have been reported.

This absence of tsetse is hard to explain, unless it is due to the entire absence of riverine tribes, together with a marked absence of crocodiles.

During late years, owing to continual raids from the east by the Marehan and Ogaden Somalis, the Gurre tribe, a few of whom used to make gardens on the banks of the Dawa River, have now deserted them, while on the banks of the Juba River, south of Bardera, where the country is free from raiders, the Gosha have large plantations, and it is here where the tsetse is said to be most plentiful, and where, to my own knowledge, crocodiles abound. Probably both *Glossina longipennis* and *Glossina pallidipes* live on human blood together with that of crocodiles, which abound in the lower reaches of the Juba, owing to the large population on its banks.

Not only did I not see a single tsetse fly myself, but the European traders stationed at Dolo told me that they had never seen any there or at Lugh, the Italian station, 30–40 miles down the river.

My best thanks are due to Mr. E. E. Austen, of the Natural History Museum, for the trouble he has taken in identifying my collection of biting flies.

NOTES ON TWO WEST AFRICAN HEMIPTERA INJURIOUS TO COCOA.

By GERALD C. DUDGEON, Inspector of Agriculture for British West Africa.

(Plate VIII.)

1. *The Cocoa* Helopeltis *from the Gold Coast.*

The insect of which drawings are given here (Pl. VIII, figs. 1 & 2) is one belonging to the genus *Helopeltis* (family Capsidæ), which contains a large number of extremely injurious species. The most important of these at present known is *H. theivora*, Westw., the "Tea Mosquito Blight" of India, which has rendered very large areas of tea-plantations in Northern India unproductive owing to the puncturing of the immature leaves. *H. antonii*, Sign., has been the cause of similar destruction to tea, cinchona and cocoa in Ceylon, but in the latter plant the puncturings are upon the pod and exactly similar to those produced by the species now figured. Dr. Trimen referred to these in 'Nature,' xxx. p. 634, 1884.

The present species, of which I have submitted my specimens to Mr. Distant for examination, are said by him to be in insufficiently good condition for description, but he remarks that the insect is near *H. schoutedeni*, Reut., which is recorded from the Belgian Congo.

Fig. 1 represents the immature form, taken at Pekki-Blengo (Anum district), where I found it puncturing the pods of cocoa, and injuring them in such a manner that the small ones were often killed; and even if a pod reached maturity, the pulp surrounding the seeds had often been attacked by fungoid growths, which had been enabled to penetrate through the decomposed area around each puncture.

The puncturing is done with the proboscis, by means of which the insect feeds upon the juices of the plant. It is not in the immature stage only that the damage is done, as the winged forms (fig. 2) are furnished with a similar strong proboscis and attack the fruit-pods in the same manner.

Fig. 3 shows the upper portion of a pod from the Krobo plantations with a few puncturings, which have only slightly distorted the shape of the pod.

The immature insect can be recognised by the red antennæ and the absence of wings. In colour it is apple-green with scarlet legs, antennæ, wing-cases and marks on the dorsal part of the abdomen. The pronotum in all stages bears a blunt erect spine which is red-tipped in the immature form. The mature or winged form has the legs dull greenish with bands of red, and red borders to the wings and thorax. The antennæ, head and tip of the thoracic spine are black.

In no instance on the Gold Coast was the damage done by this insect great, but puncturings were commonly seen in almost every plantation. The insect itself was seldom observed.

Care should be taken to prevent the spread of this pest, as it is an extremely difficult one to combat owing to its great activity. It should be looked for on punctured pods and killed whenever found, as, upon multiplication, it might become a most formidable enemy to the industry.

2. *The Cocoa Bark-Sapper* (Sahlbergella theobroma, *Distant*).

During the year 1909, Mr. Evans, Travelling Instructor of Agriculture in the Gold Coast, had his attention drawn to the ravages, in certain cocoa-growing districts in that country, of an insect which he collected and showed to me on the occasion of my last tour. I found this to be a species of Hemiptera, which has since been examined by Mr. W. L. Distant, who pronounced it to be a species of CAPSIDÆ new to science, and has recently described it under the name of *Sahlbergella theobroma* ('Entomologist,' 1909, p. 252). Another species belonging to the same genus was previously described by Dr. W. M. Graham as infesting cocoa in Southern Ashanti, but this has been found to be identical with *S. singularis*, Hagl. (Gen. ? nov. *longicornis*, Graham, Journ. Econ. Biol. iii. p. 113, pl. viii. figs. 1–2, 1908).*

The localities chiefly affected by the attacks of the bark-sapper in the Gold Coast were said to be in the vicinity of Bompata (Ashanti) and below Abetifi (Akim). In travelling through the cocoa plantations from the Anum district, on the east of the Volta, to Kumasi, by way of the Krobo plantations, Begoro, 'Mpraesu, Bompata, etc., the presence of the insect was first noticed at Abrempomsu, about 18 miles east of Begoro. At this place a new cocoa plantation had been put out in an isolated position in the heart of the forest, with intervening plantains, and most of the plants were in a dying or dead state. On examining the latter, the stalks were found to be perforated in many places, causing the bark to burst open and expose the dead cambium. Often about one foot only of each stalk showed signs of an attack, and before death had a warty and gnarled appearance; sometimes also only the terminal shoot had been sapped by the insect, causing it to wither. In this locality only young plants were present, and they appeared to have been abandoned, as the usual forest undergrowth was seen springing up thickly around them. No further indication of the pest was seen until Fenchenko was reached, but at this place several large trees exhibiting damaged bark and dead branches were seen, and examination showed that the bug was present in some numbers. Beyond 'Mpraesu the destruction appeared to be more severe, and in many

* Dr. Graham remarks: "Very large numbers of these insects were found on the diseased trees, and not on the healthy ones. They appear to damage the trees by perforating the bark and so producing gumming."

places numbers of trees of four and five years' standing had been killed. Near Mramra it was observed that the results of an attack on the main trunk, followed by partial recovery, tended to cause a growth of short bunches of leaves from the main trunk, where such conditions existed. In all severe attacks, if the tree still survived, no fruit appeared to mature, dwarf pods being formed and decomposing in a short time. The ravages were observed as far westward as Odumase near Kumasi ; but probably the worst damage was that done to the plantations in the vicinity of Bompata, where a large percentage of the trees were dying.

The accompanying drawings (Pl. VIII. figs. 4, 5 & 6) show the appearance of the insect in the larval and perfect forms. In the immature or larval form the insect appears to frequent the thick branches especially, and by puncturing the bark with its powerful proboscis saps the juices from the inner bark, which dies in large patches beneath each puncture. The mature bug, which possesses wings and is extremely active and difficult to capture, is more often seen on the thin green twigs, which it punctures in a similar manner.

Spraying with Bordeaux mixture, a preparation of sulphate of copper and lime, is being attempted, and may prove efficacious in destroying the larval forms; but a kerosine emulsion would probably prove of greater advantage, and can be applied inexpensively by means of a spraying machine or even a garden syringe. The emulsion can be made as follows :—Six or eight pounds of best soft soap are dissolved in boiling water, and while still hot, after removal from the fire, a gallon of kerosine is stirred in and thoroughly mixed by means of the syringe, with the aid of which it can be churned until the oil is diffused throughout the whole. This can be mixed with one hundred gallons of water and sprayed over the trunk and branches. The presence of soap in this, prevents the oil from separating and rising to the surface. Arsenical sprays are of no use in combating insects such as these, feeding as they do by puncturing the bark. The kerosine which forms the essential component of this mixture destroys by contact, and does not require to be consumed by the insect in order to kill it.

EXPLANATION OF PLATE VIII.

Fig. 1. Nymph of *Helopeltis* sp.

2. Mature form of *Helopeltis* sp.

3. Portion of cocoa pod punctured by *Helopeltis*.

4. *Sahlbergella theobroma*, Dist., mature form; side view.

5. *Sahlbergella theobroma*, Dist., mature form; dorsal view.

6. *Sahllergella theobroma*, Dist., nymph.

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WEST AFRICAN HEMIPTERA.

INJURIOUS TO COCOA

ON SCALE INSECTS (COCCIDÆ) &c. FROM THE UGANDA PROTECTORATE.

By ROBERT NEWSTEAD, M.Sc., A.L.S., &c.,
The School of Tropical Medicine, The University, Liverpool.

The following notes are based on a small collection of Coccidæ recently received by the Entomological Research Committee from Mr. C. C. Gowdey, the Government Entomologist in Uganda.

Stictococcus dimorphus, sp. n.

Adult female.—Hemispherical, with a distinct broad V-shaped depression on the dorsum immediately in front of the anal orifice : integument covered with short stout fulvescent spines, between which are one broad marginal and two subdorsal bands of white granular secretion ; the secretionary matter is, however, so much destroyed or hidden by a black fungus that it is impossible to ascertain definitely the exact course which it takes. The denuded integument is shining black. Venter with a large deep *marsupium* or circular orifice at the posterior extremity, occupying one-third of the ventral area ; in many instances this was filled with larvæ. Antennæ short, of four segments, and about equal in length to the anterior femur. Marginal spines resembling those on the rest of the body, but set much more closely together. Legs short, but well developed ; claw furnished with a long *ventral* digitule, which is slightly dilated anteriorly. Derm of venter with a few scattered spinnerets and also a few minute spines. Dorsal spines simple, about equal in length to the tibia, though a few examples near the margin are much longer. Anal orifice surrounded by a broad ring of chitin ; upper operculum crescentic, bearing from 7–9 hairs ; lower operculum with 4–6 hairs.

Diameter (greatest) 2·50–4 mm.

Larva of female (fig. 1).—Ovate, but gradually narrowed posteriorly. Anal orifice large ; outer ring ovate, broad ; upper operculum crescentic, with four large spinose hairs ; lower operculum narrow, taking the contour of the outer ring of chitin, this bears two spinose hairs. Dorsal spines (fig. 1 *a*) in six rows, two submedian, two submarginal, and one marginal ; those on the dorsum proper are uniform both in length and thickness and all are faintly serrate, the serrations widely separated, each tooth-like projection carrying a minute hair : the marginal spines vary considerably in length ; some of those on the cephalic and thoracic segments being equal to, if not in some instances longer than, the entire length of the body, and there are at least four similar ones at the anal extremity ; all these have the basal portions (fig. 1 *b*) faintly serrate

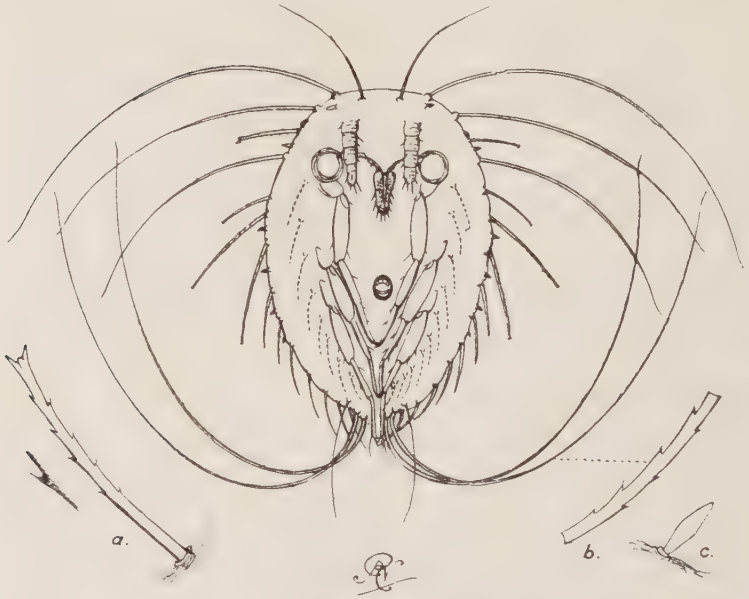

Fig. 1.—*Stictococcus dimorphus*, Newstead. Female larva.

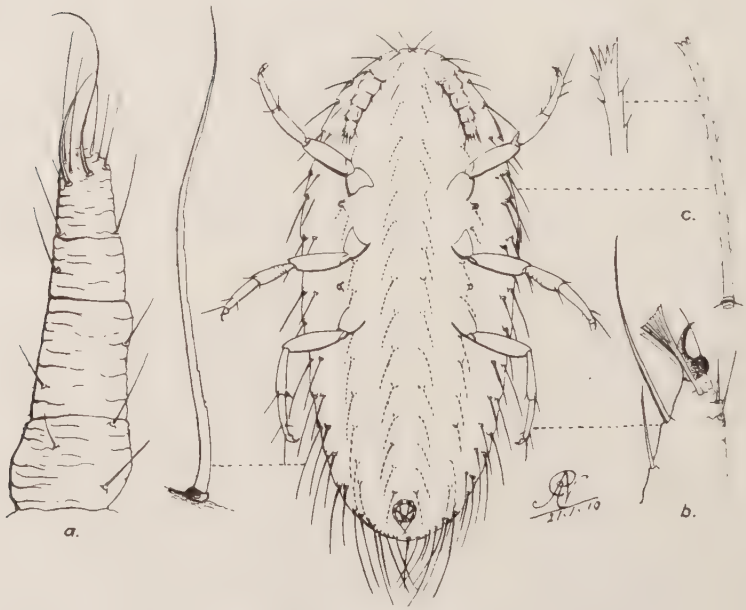

Fig. 2.—*Stictococcus dimorphus*, Newstead. Male larva.

as in the shorter spines, and all have immensely long filamentous ends, so that they may be more correctly described as *spinose* hairs; owing to the fine filamentous nature of the terminal portions of these appendages it is a somewhat difficult matter to determine their exact length, and some of them may be even longer than is shown in the accompanying figure. In addition to these there are also a few short lanceolate spines (fig. 1 *c*) irregularly interspersed between the longer appendages. Antennæ of four segments, the articulations of which are in most cases very faint; but they bear a close resemblance to those described herein as belonging to the male larva. Legs long, sparsely setose; tarsi as in the larva of the other sex (see fig. 2). Mentum biarticulate and finely setose: filaments of great length lie coiled on either side.

Larva of male (fig. 2).—Ellipsoidal. *Buccal organs obsolete.* Antennæ (fig. 2 *a*) of four segments, the third being slightly the longest; they are about equal in length to the tibio-tarsal segments together. Legs long, rather slender; ungues (fig. 2 *b*) with a strong bulbous base; lateral digitules spathulate and longitudinally striated: there is also a very long median dorsal spinose hair, and a shorter and finer ventral one; its basal or proximal portion resting apparently in the bulbous part of the claw. Dorsum with seven rows of long spinose hairs, all of them being finely but widely serrate; some of those at the margin (fig. 2 *c*) are shorter than the rest and have their apices slightly dilated and serrated as in the larva of the opposite sex. Anal orifice just within the posterior margin: this is more or less circular and is furnished with six long hairs, as in the Dactylopiinæ.

German East Africa: Langenburg (*Dr. Fulleborn*; ex coll. Zoolog. Mus. Berlin). Uganda Protectorate (*C. C. Gowdey*, on Cacao pods, December 1909).

I am not in a position at the present moment to give any further details regarding the habitat of Dr. Fulleborn's specimens. I can only add that they were forwarded to me with other Coccids collected by him in German East Africa.

This remarkable species is nearly related to *Stictococcus multispinosus*, Newstead, but the adult female is easily distinguished from the latter by the *short stout and simple spines* which clothe both the dorsum and the margin, and the presence also of a large marsupial pouch on the venter, which latter was in some few instances found to be filled with the larvæ from which the diagnosis was drawn. The most remarkable feature of this species, however, is the very extraordinary dimorphism in the larvæ, the structural characters of the sexes being most markedly differentiated. I know of no similar instance of dimorphism in the larval stages of the Coccidæ, and I believe this to be an absolutely unique instance. As will be gathered from the diagnosis given above, I have described the mouthless form as that of the male, as the mouth-parts in the adult of this sex are invariably obsolete, and furthermore

because the anal orifice is placed near the end of the body and not "in the middle of the back" (*Cockerell*), as in all stages of the female in *S. sjöstedti*, the type of the genus, and as one finds also in the larva described as the female stage of *S. dimorphus*.

All the representatives of this genus are so far confined to the African continent. *S. sjöstedti*, Cockerell, and *S. formicarius*, Newst., have a Western and South-western distribution, while *S. multispinosus*, Newst., and *S. dimorphus*, Newst., are from the Eastern side of the continent. The first and last named of these are of some economic importance as pests of the Cacao; but I have little or no information as to the exact nature of the injury caused by them to the plants which they infest. One may add, however, that a small cacao pod which was forwarded from Uganda was almost completely covered by the adult females of *S. dimorphus*, so that one may rightly assume that the fruit must have been injured by the insects to some extent. Unfortunately, the specimens arrived in very poor condition, and it is to be hoped that more perfect examples in all stages may be forthcoming. One looks forward also with no little interest to the discovery of the adult male and its puparium.

[When the cacao pod, sent home by Mr. Gowdey, reached England, two small cocoons were found on the paper in which it was wrapped. From one of these emerged a small Noctuid moth, which has been identified by Sir George Hampson as *Eublemma costimacula*, Saalm., of the subfamily Erastriinæ. It is well known that some moths of this subfamily feed in the larval stage upon Coccidæ, and it seems highly probable that in this case the *Stictococcus* had served as the food of the larvæ. In view of the possibility that the Coccid may become a serious pest, the matter deserves further attention.—Ed.]

Ceroplastes ceriferus, Anderson.

There is a slight tendency in these specimens to the formation of a short dorsal keel or ridge in the adult females as in *Ceroplastes egbarum*, Ckll. In one old adult example this character is well defined; in younger specimens it is absent. Unfortunately, one cannot say if this character is at all constant, as the series is much too small. In all other respects the examples are quite typical.

This insect may be distinguished at once from *Ceroplastes africanus*, Green, by the presence of a long caudal or horn-like process at the posterior margin and the absence of a broad flat extension in front.

Mr. Gowdey states that in Uganda this species attacks Coffee, Cacao, Agave, Canna, Croton, Hibiscus, &c. On coffee it is said to occur in sufficiently large quantities to be of economic importance.

Ceroplastes ? n. sp.

The specimens being all immature females or early adults it is not possible to fix the species with any degree of accuracy. All the more so as the wax-like tests which cover the insects are all badly damaged. Gathering from what remains of these, however, I am inclined to think that this Coccid will eventually prove to be a new and undescribed one. The tests, so far as one can make them out, are star-shaped and very like a large example of *Vinsonia stellifera*. The derm of the young female becomes thin and transparent after maceration in potash, with a very small circle of brown chitin surrounding the short anal lobes. The antennæ are of six segments: the grouped stigmatic spines normal, and there is also a single large bluntly bidentate spine in the centre of the group.

Pulvinaria psidii, Maskell.

The specimens submitted for examination agree with the description given by Maskell *, with the exception of one rather important detail regarding the structure of the marginal spines. In the examples before me these organs are generally strongly curved, slightly flattened and deeply divided at the tips; in profile, however, they appear quite simple and the more or less forked character is rendered invisible. Cockerell † has noted a similar character, however, in some cotypes which he received from Maskell, but says that the spines are "broadened and serrate at the ends." There are no truly serrated marginal spines traceable in the African examples; but these appendages are for the most part broken away, so that one cannot clear up this slight discrepancy until a larger series of specimens is available.

There is also, so far at least as one can judge from the examples to hand, a difference in the disposition of the insects upon the leaves of the food-plant.

Maskell (*l. c.*) says that "the ovisacs cover the twig or leaf with masses of dirty-white cotton, usually accompanied by a black fungus." The African specimens are sparingly scattered over the under sides of the leaves and are generally isolated or widely separated.

It may be noteworthy from an economic standpoint to add that the examples are nearly all parasitized by a Chalcidid insect of some kind. The presence of these insects may, therefore, have reduced the colonies to such an extent as to prevent the overcrowding noted by Maskell in the examples sent to him by Mr. Koebele from the Sandwich Islands.

This Coccid has not hitherto been recorded from the African continent

* Trans. New Zeal. Inst. vol. xxv. p. 223 (1892).

† Bull. Dep. Agric. Ent. Tech. iv. p. 48 (1896).

but it has a wide geographical range elsewhere. Fernald gives New Zealand; Hawaiian Islands; Formosa; Ceylon; China; Japan; California.

The food-plants recorded are Citrus, Coffee, Tea, Guava, Cinchona, Pittosporum, &c.

Mr. C. C. Gowdey states that in Uganda this species is found in numbers on the native rubber-tree (*Funtumia elastica*), occurring usually on the upper surface of the leaves and along the principal veins.

Aspidiotus lataniæ, Signoret.

The dry puparia of this Coccid so closely resemble those of *Aspidiotus destructor*, Sign., that it is practically impossible to separate the two species or to gain any clue as to their specific identity. The females of the respective species are, however, easily separable by the character of the pygidia. In *A. destructor* the median lobes are narrower and shorter than the second pair, and the median pair of spines are twice the length of the former; whereas the median lobes in *A. lataniæ* are considerably larger than the second pair and the median spines are short. Both species also infest palms of various kinds as well as other plants. *A. destructor* has already been recorded from Africa (Leonardi) and I have recently received specimens from German East Africa through the Berlin Zoological Museum.

Hitherto *A. latania* has not been recorded, so far as one can gather, from Africa, but this insect has a wide distribution and is a rather troublesome pest to cocoanut-palms in other countries. The examples sent by Mr. Gowdey from Uganda are also stated to be found on palms.

Aspidiotus cydoniæ, Comstock.

The examples are all females, a large percentage being immature or "second-stage." The circumgenital glands are rather fewer in number than has been hitherto observed; otherwise they are quite typical.

This is a widely distributed insect and also a general feeder, the principal plants attacked being Quince, Palms, *Citrus* spp., and Tea.

The Uganda specimens were also found on palms, apparently in company with the preceding species, with which they had been confused.

Puparia of a Species of Psyllidæ *infesting Orange.*

It is not possible to determine this insect from the puparium only; but in all probability it will prove to be an undescribed species. The puparia so closely resemble those of certain kinds of *Aleurodes* that they were in the first instance referred to this genus. On a more careful examination of the integument small rudimentary wing-sheaths were found, the presence of

which precludes its admission to the ALEURODIDÆ. Of the specimens examined 95 per cent. were parasitized by a small Hymenopterous insect belonging to the CHALCIDIDÆ. This is evidently the insect referred to by Mr. Gowdey* as the "Pitted Scale," but it possesses no characters in common with the COCCIDÆ.

Efforts should be made to rear the adults, a comparatively easy matter if the puparia are collected when mature.

The pits or pseudo-galls produced by this insect are very characteristic, though it is well known that many species of PSYLLIDÆ produce galls and other malformations of the leaves which they are known to infest.

21st Jan. 1910.

* Colonial Reports: Uganda, No. 64, 1909, p. 22.

A NEW GENUS AND TWO NEW SPECIES OF AFRICAN FRUIT-FLIES.

By ERNEST E. AUSTEN.

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Family TRYPETIDÆ.

Subfamily DACINÆ.

*CARPOPHTHOROMYIA**, gen. nov.

Closely allied to Ceratitis, *MacLeay, and agreeing therewith in thoracic chætotaxy*† *and venation: differing in general* facies *of body, in shape of scutellum, and in that of ovipositor, the first segment of which, instead of being flattened and truncate triangular in shape, is thickened and tubular, resembling that of* Urophora.

Cephalic bristles and shape of *antennæ* as in *Ceratitis*; *arista* plumose or pubescent; *body* in all species at present known for the most part shining black, with yellow or yellowish-white markings on the pleuræ; dorsum of *thoraæ* frequently with characteristic transverse band or bands of minute, appressed, whitish or yellowish hairs; *scutellum*,—which in the known species is entirely or mainly yellow or yellowish white,—not rounded and swollen as in *Ceratitis*, and in no way trilobate in appearance, but bluntly triangular, and flattened on the sides. *Wings* in at least one species speckled with blackish brown near the base, as in *Ceratitis*; costal spine present and distinct; first and third longitudinal veins setigerous.

Typical species *Musca vittata*, Fabr. (Ent. Syst., iv. 1794, p. 355:—*Trypeta vittata*, Loew, Berl. Ent. Z., v. Jahrg., 1861, p. 262, Tab. ii, fig. 3,—figure of wing), which, originally met with in Guinea, is represented in the Museum Collection by a male from Delagoa Bay, Portuguese East Africa (*Mrs. Monteiro*), and a male and female from Malvern, Natal, March and June, 1897 (*G. A. K. Marshall*). It may be noted that, so long ago as 1862, it was pointed out by Loew (Berl. Ent. Z., vi. Jahrg., p. 90) that this species belongs to the DACINÆ. In addition to *Musca vittata*, Fabr., and the two new species described below, *Trypeta grata*, Wied. (Auss. Zw. Ins., ii. 1830, p. 498; Loew,

* καρπο-φθόρος, spoiling fruit; μυῖα, a fly.

† For diagram of thoracic chætotaxy in *Ceratitis*, see Bezzi, Boll. del Lab. di Zool. gen. e agr. della R. Scuola Sup. d'Agric. in Portici, vol. iii. 1909, p. 275, fig. 1.

Berl. Ent. Z., v. Jahrg., 1861, p. 266, Taf. ii, fig. 6—Cape Colony), *T. tritea*, Walk. (List Dipt. Ins. in coll. Brit. Mus., iv. 1849, p. 1034—Sierra Leone), and *T. scutellata*, Walk. (Insecta Saundersiana, Diptera, Part iv. 1852, p. 384), must also be assigned to *Carpophthoromyia*. Besides the type of *C. scutellata*, which is labelled "? Senegal," the Museum possesses a female of this species from the Hinterland of Sierra Leone (*Lieut. Boyd Horsbrugh*, 1898).

It will be seen that, so far as our present knowledge goes, the genus is confined to Africa. Nothing has yet been recorded as to the life-history of any of the species, though there can be little doubt that, like those of other Dacinæ, the larvæ are destructive to fruit.

Carpophthoromyia pulchella, sp. n. (Fig. 1.)

♂ ♀.—Length, ♂ (1 specimen) 4 mm., ♀ (2 specimens) 4·8 to 5 mm.; length of proximal segment of ovipositor 1·4 to 1·5 mm.; width of head, ♂ 1·8 mm., ♀ 1·6 to 1·75 mm.; length of wing, ♂ 5 mm., ♀ 4·6 mm.

Fig. 1.—*Carpophthoromyia pulchella*, Austen. ♀ (× 6).

Head straw-yellow * *or cream-buff coloured, with dark brown markings; body shining black, scutellum, metapleura, and an oblique stripe on each side of thorax, including humeral callus and extending to posterior margin of mesopleura, Naples yellow; upper surface of abdomen with two whitish-grey or cream-buff-coloured bands, hind border of fourth segment in ♀ cinnamon-rufous; wings hyaline, with sharply defined clove-brown markings; legs buff-yellow, middle and hind femora, anterior and posterior surfaces of front femora, and extreme base of middle and hind tibiæ clove-brown.*

Head: occiput with two clove-brown blotches, narrowly separated in middle line in ♂, but meeting together, at any rate below, in ♀, in which

* For names and illustrations of colours, see Ridgway 'A Nomenclature of Colors for Naturalists' (Boston: Little, Brown, and Company, 1886).

sex they are larger ; these blotches recede from sides of head below, so as to leave more of yellow ground-colour visible in that region ; posterior orbits not conspicuous or sharply defined ; a seal-brown transverse band on upper half of front, extending from eye to eye immediately below ocellar triangle, and a second similar but slightly deeper band across lower margin of front and upper part of face, thus including point of origin of antennæ ; an inconspicuous seal-brown mark below eye on each side, extending to margin of buccal cavity ; *palpi* broad, cinnamon-coloured ; *antennæ* dark brown, first and second joints tinged with chestnut, arista pubescent, clove-brown, buff at base ; cephalic bristles, like macrochætæ on body, black. *Thorax* : dorsum with two transverse bands of minute, whitish or yellowish, appressed hairs, which contrast with the general black hue of the ground-colour ; anterior band of whitish hairs just in front of transverse suture, extending from side to side, its central region with a somewhat greyish ground, while towards its extremities, which rest on the transverse suture or even extend just across it, ground-colour may show traces of cinnamon-rufous ; posterior band, which, at least in the case of the three specimens available for examination, consists of distinctly yellowish hairs, situate between bases of wings, but not reaching lateral margins and scarcely extending beyond dorsocentral bristle on each side ; humeral calli and yellow stripe on mesopleuræ thinly clothed with pale yellow hair. *Abdomen* : on upper surface (except lateral margins) posterior third of first segment and posterior two-thirds of third segment cream-buff in ♂, whitish grey in ♀, clothed with short, glistening, yellowish-white hair ; hair elsewhere inconspicuous and mainly black, on sides of fourth segment in ♀, and on first segment of ovipositor brownish ; long bristles on sides and hind margin of fourth segment conspicuous in ♀ ; proximal segment of ovipositor tapering towards distal extremity, from which in the case of one specimen the tip of the following segment and the needle-like point of the terminal segment can be seen protruding. *Wings* : main clove-brown markings consist of a band which, commencing in second costal cell (outer costal cell of Loew) just on proximal side of bent-up terminal portion of auxiliary vein, on one hand extends along costa to tip of wing, filling space between costa and third longitudinal vein, and dipping below latter at its distal extremity so as to fill upper distal angle of first posterior cell,—and on other hand sends off a transverse branch, which starts from third longitudinal vein close to its base and terminates on sixth longitudinal vein near hind margin of wing ; this transverse branch, which at its base covers anterior transverse vein, leaves a narrow hyaline edging of irregular shape in extreme base of discal cell, and is narrower below fifth longitudinal vein ; in addition to main transverse branch just described, clove-brown costal border sends off from about its middle a narrow oblique branch of uniform width, which crosses fourth longitudinal vein and

terminates just below distal extremity of latter on hind margin of wing; a short, oblique, and somewhat paler brown band, not connected with costal border, covers posterior transverse vein, projects slightly above fourth longitudinal vein at its upper end, and at its other extremity reaches hind margin of wing so as to cover distal extremity of fifth longitudinal vein; upper extremity of this band seen against a light background is isabella colour rather than brown: base of wing, including first costal cell (inner costal cell of Loew), proximal extremity of second costal cell, proximal third of first basal cell and proximal half of second basal cell, and greater part of anal cell clove-brown, periphery or at least upper margin of first costal cell narrowly paler; hyaline area between clove-brown base of wing and main transverse band speckled with clove-brown, in such a way as to form a partial connection between the two; second costal cell with a small but conspicuous clove-brown spot in its centre, a second small spot in marginal cell immediately below, and two small flecks in third posterior cell, close to its proximal extremity; in marginal cell next costa, at a point about two-fifths of distance between distal extremities of first and second longitudinal veins, commences a narrow hyaline edging, which broadens somewhat in distal extremity of marginal cell, and is visible again as a hyaline fleck next costa in upper two-thirds of submarginal cell, either separated from second longitudinal vein or extending backwards for a short distance as a narrow edging below distal extremity of latter; when wing is held up to the light and examined with a lens, two darker flecks can be observed in costal border, in distal extremity of marginal cell, corresponding to similar flecks seen in wing of *Ceratitis capitata*, Wied.; *alula* hyaline; veins clove-brown, except costa above hyaline portion of second costal cell, and portions of fourth and fifth longitudinal veins in hyaline parts of distal half of wing, colour of which is cream-buff. *Halteres* clove-brown, basal half of stalks cream-buff. *Legs*: hair and bristles on femora and apical bristles on middle tibiæ black, row of short bristles on outer side of hind tibiæ ochraceous.

Uganda: types of ♂ and ♀ and one other ♀ from Entebbe, 15 & 24.xi.1909 (*C. C. Gowdey*).

Types in the British Museum (Natural History).

Carpophthoromyia formosula, sp. n. (Fig. 2.)

♂.—Length (1 specimen) 3·75 mm.; width of head 1·5 mm.; length of wing 3·8 mm.

Head straw-yellow, with clove-brown markings; vertex Naples yellow; body shining black, scutellum, metapleuræ, and an oblique stripe on each side of thorax, including humeral callus and extending to posterior margin of mesopleura, Naples yellow, as in preceding species; abdomen practically unicolorous, without lighter bands, though extreme posterior edge of first segment is buff, and, in

typical specimen at any rate, there is a median burnt-umber-coloured streak on terminal segment; wings hyaline, with four separate dark brown markings (occupying much less of wing-surface than in case of dark markings on wing of foregoing species), and not speckled with clove-brown near base; tibiæ and tarsi buff-yellow, femora, base of middle tibiæ and rather less than proximal half of hind tibiæ clove-brown.

Head: occiput clove-brown, with exception of sharply defined and relatively broad posterior orbits, which are very conspicuous when head is viewed from behind; front with clove-brown transverse band immediately below ocellar triangle, sides of which it encloses; *face* and area below eyes clove-brown, except an extremely narrow whitish streak in each antennal groove, an equally narrow yellowish line next the eye on the lower facial orbit on each

Fig. 2.—*Carpophthoromyia formosula*, Austen. ♂ (× 6).

side, and a narrow, ill-defined, yellowish, transverse line, interrupted in middle, across centre of face; *palpi* and *proboscis* clove-brown; *antennæ* uniformly clove-brown, arista pubescent, cream-buff at base: cephalic bristles, like macrochætæ on body, black; postorbital bristles on upper third of posterior orbits conspicuous against the straw-yellow ground. *Thorax*: dorsum clothed with minute black hairs, and with a single transverse band of similar yellowish hairs in front of transverse suture; humeral calli and oblique stripe on mesopleuræ clothed with Naples yellow hair; *scutellum* uniformly Naples yellow, entirely without dark markings. *Abdomen*: hair on dorsum entirely black, except on hind border of first segment, which is thinly clothed with whitish or pale yellowish hairs. *Wings* hyaline at base, as also throughout greater portion of their surface: starting from costa where it is joined by humeral transverse vein, a dark brown transverse band runs down into lower angle of anal cell: next dark brown mark is also a transverse band (wider than previous one but much narrower than corresponding band on wing of *C. pulchella*), base of which also rests on costa, fills distal portion of third costal cell (stigma), and extends into distal extremity of second costal cell, on

proximal side of bent-up terminal portion of auxiliary vein; this transverse band crosses base of submarginal and distal extremity of first basal cell, covering anterior tranverse vein, crosses discal cell near its proximal extremity, and terminates on sixth longitudinal vein close to hind margin of wing, diminishing somewhat in breadth below third longitudinal vein and being much narrower at its lower extremity; connected with base of this transverse band is a brown longitudinal band, which occupies almost whole of marginal cell, and from its distal extremity near distal angle of marginal cell sends off an oblique extension, which crosses submarginal cell, then becomes much narrower, and dies away in first posterior cell before reaching fourth longitudinal vein; in marginal cell distal angle and a semi-oval mark resting on second longitudinal vein, immediately below junction of first longitudinal vein with costa, are hyaline; remaining brown markings consist of a longitudinal stripe running along distal extremity of costa and extending from upper distal angle of submarginal cell into upper distal angle of first posterior cell (brown costal border of distal portion of wing thus being interrupted just before junction of second longitudinal vein with costa), and a narrow oblique band, which, starting from hind margin at point where it is joined by fifth longitudinal vein, covers posterior transverse vein and terminates in first posterior cell just above fourth longitudinal vein and well on proximal side of junction of latter with posterior transverse vein; *alula* hyaline; veins dark brown, except in hyaline parts of wing, where they are for most part cream-buff or buff. *Halteres* buff. *Legs*: hair and bristles on femora and apical bristles on middle tibiæ black, row of short bristles on outer side of hind tibiæ and on externo-posterior side of middle tibiæ brownish.

Uganda, 1909 (received from *Colonel Sir David Bruce, C.B., A.M.S., F.R.S.*).

Type in the British Museum (Natural History).

The six species of *Carpophthoromyia* at present known may be distinguished as follows:—

1.	Scutellum entirely yellow	2.
	Scutellum partly clove-brown or black, or with clove-brown or black markings	4.
2.	Brown costal border of distal portion of wing interrupted	*formosula*, Austen.
	Brown costal border of distal portion of wing entire	3.
3.	Brown costal border sending off a branch towards tip of wing.	*pulchella*, Austen.
	Brown costal border of wing sending off no such branch	*scutellata*, Walk.
4.	Tip of scutellum clove-brown	*vittata*, Fabr.
	Tip of scutellum not clove-brown, but posterior margin of scutellum marked with clove-brown or black spots	5.
5.	Humeral calli dark brown	*tritea*, Walk.
	Humeral calli yellow	*grata*, Wied.

Although the British Museum collection as yet contains no specimen of *Trypeta grata*, Wied., judging from Loew's description of the species and figure of the wing, referred to above, there can be little doubt that this species also belongs to *Carpophthoromyia*. The scutellum is said to have "three large, quadrate, shining black spots," visible from above, on its posterior margin (*C. tritea*, Walk., has three clove-brown spots on the posterior margin of the scutellum, but these are not visible from above); the clove-brown or black costal border sends off a branch towards the tip of the wing, as in *C. pulchella*, Austen, but the marking on the basal half of the wing is different, and the band covering the posterior transverse vein is almost triangular ("wedge-shaped," *apud* Loew, *loc. cit.*, p. 268), being broader on the posterior margin of the wing. As stated in the foregoing table, the humeral calli are yellow, and this character alone will serve to distinguish the species from *C. tritea*, Walk., in which the marking of the scutellum is somewhat similar, but the humeral calli are dark brown.

A NEW SPECIES OF *CORDYLOBIA*, A GENUS OF AFRICAN DIPTERA (FAMILY TACHINIDÆ, SUBFAMILY CALLIPHORINÆ), THE LARVÆ OF WHICH ARE SUBCUTANEOUS PARASITES IN MAN AND OTHER MAMMALS.

By ERNEST E. AUSTEN.

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Cordylobia prægrandis, sp. n.

♀.—Length (3 specimens) 15·6 to 16·5 mm.; width of head 6·25 to 6·5 mm.; width of front at vertex 2·5 mm.; length of wing 14·75 to 15 mm.

Body saffron-yellow, with black markings (somewhat toned down by a hoary bloom) as shown in figure; wings with a brownish tinge; femora orange-buff;

Cordylobia prægrandis, Austen, ♀. (× 3.)

tibiæ and tarsi buff-yellow.—Strikingly similar to C. anthropophaga, *Grünb.*, ♀, *in general coloration and markings, but, in addition to its much larger size, distinguished by more elongate form of abdomen (due to increased length and*

more triangular shape of fourth segment), by absence of dark, quadrate, median, longitudinal mark on dorsum of second abdominal segment, by dark transverse band on hind border of same segment being relatively narrower, more sharply defined, and not or scarcely expanded at sides, and by distal three-fourths of infero-lateral margins of dorsal scute of fourth abdominal segment being approximated so closely on ventral side as to leave but a narrow cleft between them, and being each fringed with a dense row of stout, black setæ.

Head chrome-yellow, frontal stripe orange-buff; area between ocelli dark brown; *palpi* buff-yellow, clothed with black bristles; *proboscis* ochraceous-rufous, clothed with ochraceous hair; *antennæ* (including arista) ochraceous-buff to ochraceous-rufous, second joint clothed above with short black bristles, hairs on arista brown; orbital bristles small, one (sometimes two) on each side; all bristles on head, body and legs black; jowls and basi-occipital region clothed with bright, buff-yellow hair. *Thorax*: median portion of dorsum, between dark longitudinal marks, buff pollinose, showing ground-colour in three darker longitudinal streaks (most conspicuous in front of suture), as in figure; dorsum clothed with fine, erect, black hair, mingled, especially towards hind margin, with bright, buff-yellow hair; pleuræ greyish pollinose, clothed with bright, buff-yellow hair, upper part of mesopleuræ with black hair; infero-lateral margins of scutellum clothed with bright, buff-yellow hair. *Abdomen*: dorsum clothed with minute, appressed, black hairs; yellow area on third segment sometimes of much less extent than that shown in figure, being confined to a narrow edging on front margin, and a small and scarcely visible notch-like median indentation in anterior edge of black area; fourth segment in each of the three specimens available for comparison showing a median depression on upper surface; amount of yellow on this segment variable in extent, and sometimes greater than shown in figure, almost reaching front margin in middle line, front margin and basal angles being also narrowly yellow; tip of fourth segment with a row of stout black setæ, from three to five on each side of middle line, as in figure; first segment clothed below for the most part with bright ochraceous hair; incurved portions of dorsal scutes of remaining segments clothed, like dorsum, with minute black hairs, mixed with bristles in case of fourth segment, and with ochraceous hairs in case of second, and to a lesser extent in that of third segment. *Wings*: veins tawny to mummy-brown, extreme base and part of first longitudinal vein below humeral cross-vein ochraceous. *Squamæ*: alar pair hyaline or nearly so, with thickened border ochraceous-buff; thoracal squamæ buff or cream-buff, semi-opaque. *Halteres* buff. *Legs* clothed with black hair and bristles; claws black, ochraceous-rufous at base.

Cape Colony: Deelfontein, 24. xii. 1902 (*Colonel A. T. Sloggett, C.M.G., R.A.M.C.*)—type; Natal: Durban, vi. 1891 (*Dr. H. A. Spencer*); N.W. Rhodesia: Kasempa District, 3500–4500 ft., 1909 (*E. A. Copeman*).

Type and two other specimens in the British Museum (Natural History).

Although nothing is yet known as to the life-history of this species, it is reasonable to suppose that, like the other members of its genus, *Cordylobia prægrandis* is in its larval stage a subcutaneous parasite in mammals. Whether or not it resembles *C. anthropophaga*, Grünb., and *C. rodhaini*, Gedoelst, in regularly attacking man, it may be pointed out that the larva of so large a fly must be of very considerable size, and is consequently little likely to be permitted to remain in the human integument long enough to attain its maximum development, so as to enable the perfect insect to be bred.

ON THE PARASITES OF TWO SPECIES OF WEST AFRICAN WILD SILK-WORMS.*

By GERALD C. DUDGEON, Inspector of Agriculture for British West Africa.

The silk derived from the cocoon-masses woven by the larvæ of *Anaphe infracta*, Wlsm., *A. venata*, Butl., *A. molonegi*, Druce, and others of the same or an allied genus of the family Eupterotidæ, is utilised in the Haussa and

Cocoon-mass of *Anaphe venata*, Walk, enclosed in an outer case, on a leaf of Cassava. (From a photograph by Dr. W. M. Graham.)

Yoruba countries of Northern and Southern Nigeria for the manufacture of yarns, used in the embroidery of Haussa gowns in the former country and, in conjunction with cotton in the latter locality, for the production of the "sanyan" cloths.

* Received from the Colonial Office for publication.—Ed.

Observations in connection with the cocoons of *A. infracta* and *A. moloneyi* show that they are very largely parasitized by at least one species of Ichneumonidæ (Hymenoptera), two Phycitinæ (Lepidoptera), and a *Tachina* (Diptera).

The Ichneumon belongs to a species which is placed in the British Museum collection under the name of *Cryptus formosus*, Brullé (described in 1846). This is a shining-black insect, with some red upon the head and pronotum and a broad white band on the middle of the antennæ, the wings being purplish blue with a broad hyaline bar. M. Fleutiaux in "L'*Anaphe moloneyi* et ses parasites" (L'Agric. Prat. des pays chauds, No. 71, Feb. 1909, pp. 162–3) mentions a similar insect attacking *A. moloneyi* in the Western Sudan, which has been named *Cryptus vittatus*, Tosq. (Mém. Soc. Ent. Belg., v., 1896, p. 148). In making a comparison of the descriptions of the two species, there does not appear to be any character of sufficient importance to separate them. For this reason the British Museum identification should probably be applicable to both. *C. formosus* has been obtained by me from the cocoons of *A. infracta*, from Ibadan (Southern Nigeria), and from those of *A. moloneyi* from Muri (Northern Nigeria).

Two moth larvæ of the subfamily Phycitinæ have been found infesting the cocoons of *Anaphe*. One of these is *Metoecis carnifex*, Coq., which perforates the newly-formed cocoons of *A. infracta*, and pupates within the cocoon envelope. The insect probably attacks and destroys the silk larvæ when they are just preparing to pupate, as the perforated cocoons are found to contain excreta only after the parasite has passed out into an adjoining cocoon. Sir George Hampson remarks that another species of *Metoecis* has been bred from the cocoons of *A. moloneyi*.

From some batches of cocoons of both species of silk moths examined by me in 1908, a number of Tachinid flies emerged, but these have not been identified further than being placed in the genus *Tachina*. M. Fleutiaux mentions a specimen of *Tachina bella*, Meigen *, as having been bred from the cocoons of *A. moloneyi*.

* Mr. E. E. Austen states that the actual identity of the *Tachina bella* of Meigen is very doubtful. It is, however, certainly a European species, and it is not likely therefore to occur in Tropical Africa.—Ed.

A METHOD OF DESTROYING TSETSE-FLIES.

The following account of a very successful device for trapping *Glossina palpalis* was published in a recent number of the 'Sleeping Sickness Bulletin,' (vol. ii. no. 13, Jan. 1910, p. 26), and is well deserving of an extensive trial in all *Glossina* areas:—

"Mr. Maldonado, manager of one of the estates on the Island of Principe, has devised a method of destroying *Glossina palpalis*. Noticing that the flies attacked the backs of the labourers when they were occupied in mowing grass, and were consequently in a stooping posture, he ordered that such labourers should wear a black cloth covering their backs, coated with a glutinous substance [apparently bird-lime] on its outer surface. *Between April* 1906 *and the end of* 1907, 133,778 *tsetse were thus trapped on this plantation alone*. While the Portuguese Commission was in the island there were not more than four persons who went about with these cloths. The Commission often asked Mr. Maldonado to send men with black cloths to places where they had seen a large number of flies. 'As a rule two men were enough in the short space of a week to make these places passable (*practicables*).' On the first days the numbers taken would be 1500–2000; at the end of the week 15 or 20. The method has been tried on two other estates with the same favourable results."

It may be pointed out that the predilection for settling on dark surfaces is by no means peculiar to *G. palpalis*, but is evinced by all blood-sucking Diptera. Seeing that there has recently been an outbreak of nagana in several parts of Southern Rhodesia, it is to be hoped that an organised attempt will be made there to test the efficacy of this method for destroying *Glossina morsitans*. It is possible that suitably devised cloths of this kind would afford an efficient protection to cattle when being driven through a fly-belt; and in most parts of Hartley and Lomagundi Districts there should be no difficulty in obtaining adequate supplies of bird-lime.

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen who have presented collections of insects :—

1909.

Sept. 28. Mr. J. H. J. Farquhar, Provincial Forest Officer, Southern Nigeria :—1 *Glossina fusca*, 2 *G. palpalis*, 2 *Chrysops silacea*, and 3 *Tabanus secedens*, from Cross River, S. Nigeria.

Oct. 6. Dr. T. G. Wakeling :—*Phlebotomus papatasii*, from Cairo.

„ 11. Hon. Walter Rothschild :—18 *Hyalomma aegyptium* off a Giraffe, from Ogo, Senegal.

Nov. 8. Senhor José de Oliveira Serrão de Azevedo, Chief Health Officer of Mozambique :—69 Diptera, belonging to 64 species, from Delagoa Bay.

„ 28. Mr. C. C. Gowdey, Government Entomologist :—Insects injurious to agriculture in Uganda, comprising 45 Coleoptera (6 species), 1 *Gryllotalpa africana*, 6 Diptera (*Ceratitis punctata* and *C. capitata*), 2 Rhopalocera (*Papilio demodocus* and *Acræa terpsichore*), 12 Lygæidæ (3 species), 1 species of Psyllidæ, and 6 species of Coccidæ.

Dec. 2. Dr. R. E. Drake-Brockman :—49 ticks (3 species of *Rhipicephalus*) and 9 *Ctenocephalus felis* off a dog, and 5 Diptera (*Lyperosia minuta* and *Raymondia* sp.), from Upper Sheikh, British Somaliland.

„ 6. Senhor José Firmino Sant'Anna :—25 mosquitoes (4 species), with larvæ of one species, from Delagoa Bay.

„ 17. Mr. C. C. Gowdey :—72 Hymenoptera (42 species), from Uganda.

1910.

Jan. 1. Mr. C. C. Gowdey :—18 ticks (*Aponomma exornatum* and *Boophilus decoloratus*), from Entebbe, Uganda.

„ 7. Mr. C. C. Gowdey :—39 Coleoptera (26 species), 7 Orthoptera (5 species), 1 species of Odonata, 11 Hemiptera (6 species), 3 Homoptera (1 species), and 13 Diptera (10 species), from Uganda.

„ 15. Mr. C. F. M. Swynnerton :—124 Coleoptera (100 species), 34 Orthoptera (22 species), 70 Hymenoptera (28 species), 8 Neuroptera (5 species), 32 Hemiptera (18 species), 22 Diptera (7 species), 11 Ixodoidea (4 species), from Mount Chirinda, Melsetter District, S. Rhodesia.

Feb. 3. Dr. T. G. Wakeling :—20 blood-sucking Diptera (4 species), 72 Cimicidæ, 48 *Pulex irritans*, a large number of *Pediculus*, and 17 Ixodoidea (*Hyalomma ægyptium* and *Boophilus australis*), from Kadassah, Libyan Desert.

„ 19. Mr. C. C. Gowdey :—65 Coleoptera (10 species), 39 Hymenoptera (17 species), and 2 Homoptera (1 species), from Uganda.

„ 24. Dr. W. M. Graham, Director of W. African Medical Research Institute :—179 named Culicidæ (28 species), with authenticated larvæ of 29 species and 13 other biting flies (9 species), from Lagos, S. Nigeria.

A SYNOPSIS OF THE FLEAS FOUND ON *MUS NORWEGICUS DECUMANUS*, *MUS RATTUS ALEXANDRINUS* AND *MUS MUSCULUS*.

By the Hon. N. CHARLES ROTHSCHILD.

The three species of the genus *Mus* mentioned above follow in the wake of civilised man and may be looked upon as more or less domestic animals. Moreover, when they appear in any new locality, they seem to possess the power of eliminating the previously established native species of rats and mice, and they thus obtain for themselves a wider field and the opportunity for a rapid permanent increase in number of individuals. Of the three, *Mus rattus* alone habitually infests ships, but by accidental transference in vessels from port to port all three have become distributed throughout the world. Australia is especially rich in peculiar local species of rats, abundantly distinct from, but to some extent resembling, *Mus rattus*. This circumstance renders it not improbable that on occasion animals from Australia may have been incorrectly identified with that cosmopolitan species.

In connection with the spread of plague the three species under consideration are of prime importance, and not less important are the fleas which are parasitic on them. The object of the present paper is to assist students and others towards the rapid identification of the fleas usually found on the common rats and mice.

Family I. Chigoes (Sarcopsyllidæ).—The rostrum (= labium + labial palpi) consists of three, or fewer, very feebly chitinized segments. The genal edge of the head is in all cases produced downwards into a triangular lobe situated behind the mouth-parts (fig. 1). There are no combs. The three segments of the thorax are always shorter than the first abdominal tergite.

The Sarcopsyllidæ are not in any way confined to one host and therefore many of the species may occur on rats. They usually attack the head and ears, and more rarely the feet.

Key to the Genera.

a. Hind coxa without a patch of spines on the inside.
  *a*¹. Hind femur simple ..... 1. *Dermatophilus*.
  *b*¹. Hind femur with a large tooth-like projection near the base .. 2. *Hectopsylla*.
b. Hind coxa with a patch of short spines on the *inside* (fig. 2) ..... 3. *Echidnophaga*.

1. Genus Dermatophilus, Guér.

Two species are known. Pregnant ♀ is much swollen and round, like a small pea.

1. **D. penetrans**. L. Eye distinct. Head and thorax of pregnant ♀ outside the swollen abdomen.—This is the common Chigoe or Jigger, which is a native of South America, but has been introduced into Africa.

2. **D. cæcata**, Enderl. Eye vestigial. Head and thorax of pregnant ♀ completely covered by the abdomen and lying in a cavity formed by the latter (fig. 3). Male unknown.—The species has been taken in Brazil on and behind the ears of *Mus rattus*.

2. Genus Hectopsylla, Frauenf.

This genus has not been found on rats or mice. It was originally confined to America, but one species has been introduced into aviaries in Europe.

3. Genus Echidnophaga, Olliff.

The genus belongs to warm countries in the eastern hemisphere. Numerous species are known, four of which have been found on rats.

Key to the Species.

a. Fifth tarsal segment with three heavy bristles, one small one and a thin long subapical hair on each side (fig. 4).

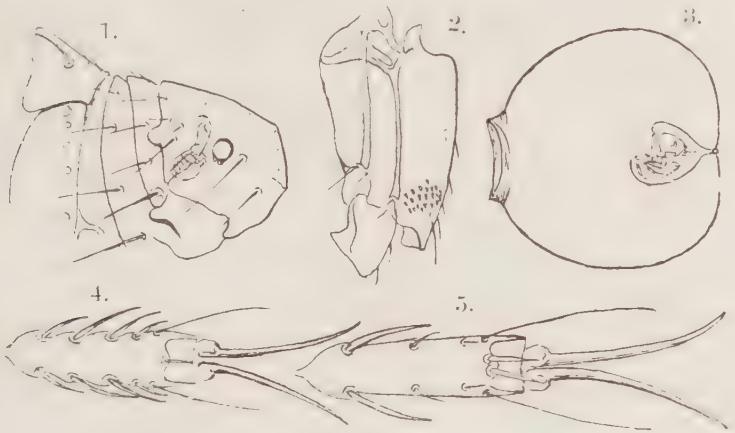
1. **E. gallinaceus**, Westw. Fifth tarsal segment with two ventral apical bristles (as in fig. 5); hind edge of head with a lateral lobe (fig. 1).—A common species, particularly on the heads of fowls, in tropical Asia and Africa; introduced into the United States. Also found on rats in Africa.

2. **E. myrmecobii**, Rothsch. Fifth tarsal segment with one ventral apical bristle (as in fig. 4); hind edge of head with a lateral lobe.—Belongs to Australia, where it has been taken on several indigenous animals and also on rats.

3. **E. murina**, Tirab. Fifth tarsal segment with one ventral apical bristle (fig. 4); hind edge of head without distinct lateral lobe.—A native of southern and south-eastern Europe, where it occurs on the heads of rats; it is apparently rare.

b. Fifth tarsal segment on each side with one heavy sub-basal bristle, a thinner median one and a small postmedian hair (fig. 5).

4. **E. liopus**, Rothsch. Found on rats in India; originally described from Western Australia, where it is plentiful on *Echidna*.

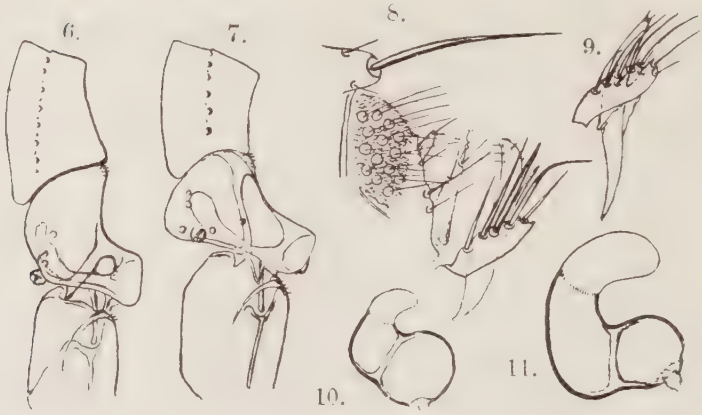


Family II. True Fleas (PULICIDÆ).—The rostrum (=labium+labial palpi) consists of four or more segments in the species found on rats and mice. Many species have combs of heavily chitinized spines. The majority of the known fleas belong here. For practical purposes they may be divided into two sections:—

Section 1.—Club of antenna distinctly segmented only on the hind side ("hind" side when lying in the groove).—(Section 2, p. 94.)

Key to the Genera.

a. No comb on head and thorax.
  *a*¹. The internal incrassation, which extends from the insertion of the mid coxa into the thorax, joins the anterior edge of the mesosternite (fig. 6) ..... 4. *Pulex*.
  *b*¹. This incrassation joins the upper edge of the mesosternite (fig. 7) ..... 5. *Xenopsylla*.
b. With a comb on the pronotum only ..... 6. *Hoplopsyllus*.
c. With a comb on the pronotum and at the lower edge of the head (figs. 12 & 13) ..... 7. *Ctenocephalus*.



4. Genus Pulex, L.

1. **P. irritans**, L. The human flea. Occasionally found on rats. Practically cosmopolitan.

5. Genus Xenopsylla, Glink.

The name *Loemopsylla*, Jord. and Rothsch., was published a little later than *Xenopsylla*, and must therefore give way to the latter. The genus includes numerous species from Africa: one of them (*cheopis*, Rothsch.) is now practically cosmopolitan, and another (*brasiliensis*, Baker) has been introduced into South America.

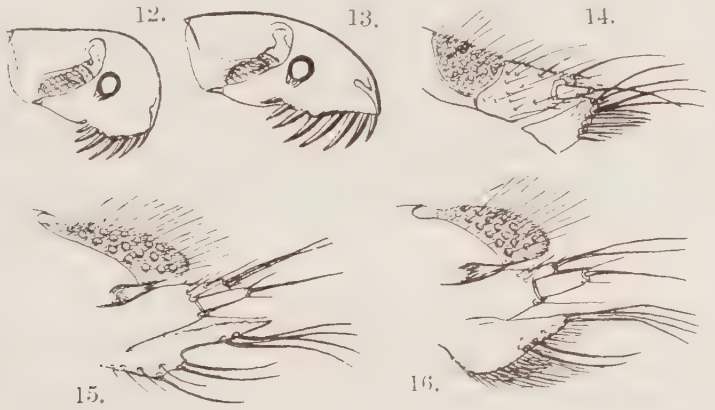
1. **X. cheopis**, Rothsch. In the ♂ the bristles of the flap-like process of the clasper all slender (fig. 9). In the ♀ the narrow portion of the receptaculum seminis long (fig. 11).—Originally discovered in Egypt. This is the common flea of rats in the tropics. Although practically cosmopolitan, it cannot apparently flourish in temperate and cold climates.

2. **X. brasiliensis**, Baker (=*ciquetus*, Rothsch.). The bristles of the flap-like process of the clasper of the ♂ nearly all very stout, one of them elbowed (fig. 8); antepygidial bristle of male on a conical projection (fig. 8). The narrow part of the receptaculum seminis of the ♀ much shorter than in *X. cheopis*, and the rounded portion larger (fig. 10).—Occurs on rats in West Africa and has been introduced into Brazil. All the species of this genus are closely allied, and great care must be taken in their identification. The organs here figured are practically constant in each species.

6. Genus Hoplopsyllus, Baker.

Nearly related to *Pulex*. At once recognised by the prothorax bearing a comb, as in *Ceratophyllus*. The club of the antenna is segmented only on the hind side, as in *Pulex* and *Xenopsylla*, the first midtarsal segment is much shorter than the second, and the fifth tarsal segment in *all* the tarsi has four bristles on each side, besides a thin and long subapical hair. North American fleas; one species found on rats, but only once.

1. **H. anomalus**, Baker. The comb of the prothorax consists of about 8 to 10 spines.—Colorado and California.



7. Genus Ctenocephalus, Kolen.

Two species, which, although confounded by many authors, are easily distinguished by the shape of the head.

1. **Ct. canis**, Dugès. Frons of the head strongly rounded (fig. 12, ♂). Manubrium of clasper of ♂ widened at the end.—The flea commonly found on the dog, but also occurring on rats. Practically cosmopolitan, but more abundant in temperate countries than in the tropics.

2. **Ct. felis**, Bouché. Frons of the head much less rounded than in *canis*, the head therefore longer (fig. 13, ♂). Manubrium of the clasper (♂) only a little widened at the apex.—A widely distributed and very common flea all over the world on rats as well as many other animals.

Section 2.—Club of antenna distinctly segmented all round.

Key to the Genera.

a. Eye developed (*cf.* figs. 12, 13, & 26).
  *a*¹. No comb on head.
    *a*². Pygidium not projecting backwards (fig. 14); frons with tubercle ..... 8. *Ceratophyllus.*
    *b*². Pygidium strongly convex, projecting backwards (figs. 15 & 16); frons without tubercle ..... 9. *Pygiopsylla.*
  *b*¹. Two spines at angle of gena (fig. 26) ..... 10. *Chiastopsylla.*
b. Eye vestigial or absent (figs. 27 & 28).
  *a*¹. Abdomen without comb.
    *a*². Hind edge of tibiæ with about 8 short and several long bristles, which do not form a comb.
      *a*³. Fifth segment in fore and mid tarsi with five, and in hind tarsus with four lateral bristles ..... 11. *Neopsylla.*
      *b*³. Fifth segment in fore and mid tarsi with four and in hind tarsus with three lateral bristles, there being an additional pair of bristles in all the tarsi on the ventral surface in between the first pair ..... 12. *Ctenophthalmus.*
    *b*². Hind edge of tibiæ with about 12 short and 3 long bristles, the short ones forming a kind of comb ..... 13. *Ctenopsylla.*
  *b*¹. Abdomen with at least one comb..... 14. *Hystrichopsylla.*

8. Genus Ceratophyllus, Curtis.

The number of species is very large; many of them are found on birds, but five only have been recorded from rats or house-mice.

1. **C. fasciatus**, Bosc. The comb of the prothorax consists of 18–20 spines. The movable process of the clasper of the ♂ (fig. 18) has the proximal edge angulate. The sternite of the seventh abdominal segment is slightly sinuous, without distinctly projecting lobe (fig. 20).—This species is common on *Mus norwegicus* in Europe, and occurs elsewhere as well.

2. **C. londiniensis**, Rothsch. The comb of the prothorax consists of 17–19 teeth. The movable process of the clasper of the ♂ is longer than in *fasciatus*, pointed and widest near the centre; its proximal margin is non-angulate (fig. 17). The sternite of the seventh abdominal segment of the female has a broad truncate lobe (fig. 19).—The species is widely distributed on rats and mice. It is apparently rare, but a large number of specimens were once taken in London (South Kensington).

3. **C. anisus**, Rothsch. The comb of the pronotum consists of 18 spines. The eighth abdominal sternite of the ♂ similar to that of *C. niger* (*cf.* fig. 23), but slenderer. The ♀ not known.—Originally described from Japan, where a ♂ was obtained off *Felis* sp. Another specimen was found at San Francisco, California, taken off *Mus norwegicus*.

4. **C. penicilliger**, Grube*. The prothoracic comb consists of 20–22 spines. The movable process of the clasper of the ♂ is widest proximally to the centre and bears here at the hind edge two short, thick, obtuse spines; between these spines and the tip of the movable process there are two short, but rather strong, pointed bristles, the lower one pointing downwards and the upper one upwards. The eighth sternite is long and bears two very long bristles at the tip. The sternite of the seventh abdominal segment of the ♀ is, on each side, divided by a very shallow sinus into two rounded lobes.—Found on rodents and small carnivora in Europe and North Asia; one specimen taken off *Mus norvegicus* at Rannoch, Scotland. This flea, like *Ctenophthalmus agyrtes*, is very common on field-mice in England.

5. **C. niger**, Fox. The comb of the prothorax consists of at least 28 spines. The sternite of the eighth abdominal segment of the male is long and rod-like and bears a number of long bristles at the apex (fig. 23); (this sternite is practically lost in *fasciatus* and *londiniensis*). The receptaculum seminis of the female is long and slender, the proximal portion being but little wider than and almost twice the length of the distal portion, while in the two above-mentioned species the proximal portion is short and globular.—A bird-flea from California, but also occurring on rats.

9. Genus Pygiopsylla, Rothsch.

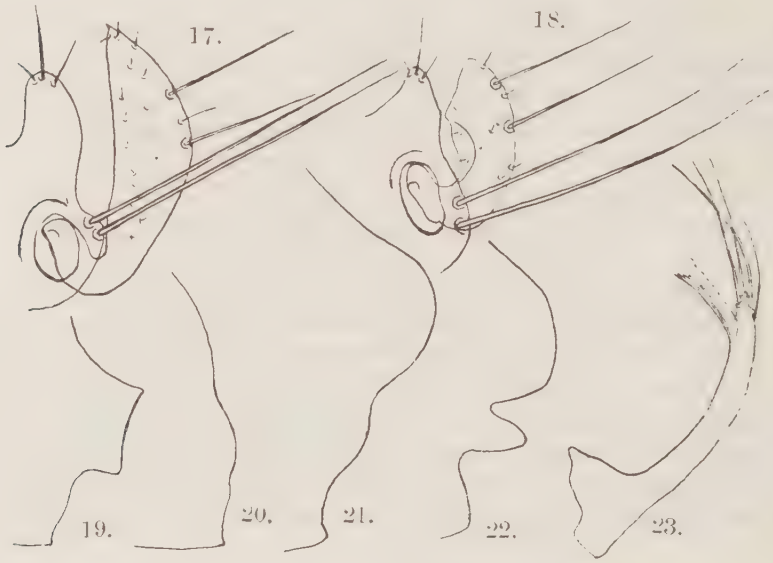
A number of species are known from the tropical countries of the eastern hemisphere, two being recorded from rats. Specimens of both these fleas have been sent from Australia labelled "from *Mus rattus*"; but subsequent examinations of large numbers of this animal in the same locality have not yielded any more. As both fleas are common on *Mus assimilis*, a purely Australian animal, it is probable that the hosts called *rattus* were really *assimilis*.

1. **P. hilli**, Rothsch. The sternite of the third abdominal segment in the ♂ bears on the two sides together about 20, or fewer, slender hairs in front of the postmedian row of long bristles; the movable process of the clasper is about half as long again as the non-movable process. In the ♀ the anal sternite (fig. 15) is notched beneath.—Australia.

2. **P. rainbowi**, Rothsch. A larger species. In the ♂ the sternite of the third abdominal segment bears on the two sides together more than 40 hairs in front of the postmedian row of long bristles: the movable process of the

* Dr. C. Tiraboschi, and others following him, have erroneously recorded *C. consimilis*, Wagner, *C. lagomys*, Wagner, and *C. mustelæ*, Dale, as being found on rats in Europe.

clasper is about one-fourth longer than the non-movable process. In the ♀ the anal sternite is evenly convex beneath (fig. 16).



10. Genus Chiastopsylla, Rothsch.

The genus includes a few species from South Africa, one of which has been obtained from a rat.

1. **Ch. rossi**, Waterst. Only one female known, which was taken off a rat in South Africa. Probably a common insect.

11. Genus Neopsylla, Wagn.

Very near *Ctenophthalmus*, but easily distinguished by the fifth tarsal segments bearing no ventral pair of bristles in between the first lateral pair. A small number of Palæarctic species, one of which was obtained from a rat.

1. **N. bidentatiformis**, Wagn. Head with two spines at the genal edge nearly as in *Chiastopsylla* (fig. 26).—Russia.

12. Genus Ctenophthalmus, Kolen.

The species are numerous. The eye is vestigial; the head bears a comb, and about midway between the palpi and the antennal groove there is a distinct frontal tubercle situated in a groove. Two species are recorded from rats.

1. **Ct. agyrtes**, Heller. The genal comb consists of three teeth and the pronotal one of sixteen. The non-movable process of the clasper of the male (fig. 25) is separated by a sinus into a conical upper lobe and a shorter and broader lower lobe, the latter being sinuate; the movable process is conical. In the female the sternite of the seventh abdominal segment (fig. 22) is produced into a broad rounded lobe, beneath which there is a narrow second lobe.—This is a European species, common in England on field-mice and bank-voles, and occurring also on *Mus norvegicus* when captured in the open.

2. **Ct. assimilis**, Tasch. The genal comb consists of three teeth and the pronotal one of eighteen. In the ♂ the non-movable process of the clasper (fig. 24) is short and broad and bears a number of long bristles; the movable process has the shape of a boot held with the sole upwards. The sternite of the seventh abdominal segment of the female (fig. 21) is produced into a broad rounded lobe, beneath which the edge of the segment is twice slightly incurved.—The species is found in Central Europe on field-mice; it is common in Germany on *Arvicola arvalis*, and has also been recorded from rats; it is apparently not found in England.

13. Genus Ctenopsylla, Kolen.

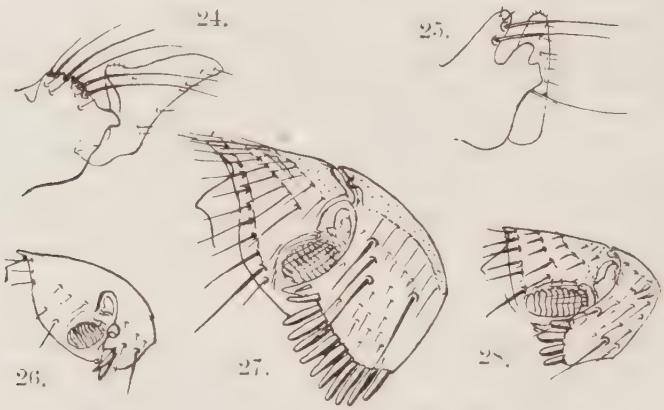
The species are easily recognised by the shape of the head (fig. 28) and the comb-like arrangements of the bristles at the hind edge of the tibiæ. One of the species has been obtained from rats.

1. **Ct. musculi**, Dugès. Two of the bristles near the front angle of the head are spine-like.—A widely distributed species, very common on rats and mice, especially *Mus musculus*, with which it has spread.

14. Genus Hystrichopsylla, Tasch.

The few known species are all large and very hairy fleas, which are at once recognised by the abdomen bearing one or more combs and the eye being absent or vestigial. One species has been found on rats.

1. **H. tripectinata**, Tirab. The comb of the head is restricted to the lower edge of the gena (fig. 27). The abdomen bears one comb, which is situated on the first tergite, each of the other tergites bears some small apical spines.—This is a Mediterranean species which occurs on mice and rats; it has also been found in the Azores.



The Californian ground squirrel *Citellus beecheyi* has been proved to play an important part in plague infection in California. A full account of the fleas of this animal is given in U.S.A. Public Health Reports, vol. xxiv. no. 29, 1909, Washington, Government Printing Office.

SOME OBSERVATIONS ON THE BIONOMICS OF *TABANUS PAR*, WALKER, AND *TABANUS TÆNIOLA*, PAL. DE BEAUV.

By HAROLD H. KING,
Government Entomologist, Anglo-Egyptian Sudan,
Wellcome Research Laboratories, Khartoum.

(Plate IX.)

Notwithstanding the work which has been conducted during the last few years on blood-sucking flies, and particularly on those which occur in Tropical Africa, owing to their connection, whether proved or merely suspected, with the spread of various diseases of man and animals, nothing has hitherto been published on the life-history of any African species of the large family Tabanidæ, except in the case of *Tabanus biguttatus*, Wied.* It is hoped, therefore, that the following notes on the bionomics of two of the more common Tabanids, though incomplete, may nevertheless be of some interest.

The figures illustrating this paper are by Mr. A. J. Engel Terzi, while Mr. E. E. Austen, of the British Museum (Natural History), has very kindly supervised their production.

Tabanus par, Walker.

Occasional specimens of this Tabanid are met with on the White Nile from Gebelein southwards, but it is rarely noticed boarding river-steamers in any numbers. In the country behind Bor there were several small belts where females abounded, but no males were seen. These females spent their time resting among the vegetation, especially the low dom palms, until some animal, such as a cow, approached, when they would at once fly off and attack it. They did not, however, seem to follow cattle very far. No eggs could be found, though a careful search was made in all the places that were considered likely to serve as breeding-grounds, so a number of females, gorged with blood, were placed in a breeding-cage, in which was also a dish containing mud, water and growing grass and weeds. They fed on sugar and water, and though the majority died within the first two days, the survivors eventually produced three small batches of eggs.

On some flowering bushes by Khor Felus, on the Sobat river, about seven

* King, H. H.: Third Report of Wellcome Research Laboratories, Gordon Memorial College, Khartoum.

miles from its junction with the White Nile, several males were taken, feeding on the flowers. Only two or three females were seen, but as there were no cattle grazing in the immediate vicinity it is probable that they had gone farther afield in search of more satisfying food.

The eggs, obtained as described above, were deposited on May 23rd and 24th, on the undersides of the leaves of a water-weed. Unlike the eggs of most members of the genus *Tabanus*, they were not closely packed in a rounded mass, but placed vertically and separately, though in a cluster. They hatched on May 30th, and the tiny larvæ were divided into three lots, and placed in glass basins containing mud, water and growing grass. These basins for purposes of reference were labelled A, B and C.

At the time when the eggs hatched, the writer was in the Sud region, where it was impossible to land and obtain any subterraneous insect larvæ or tiny fresh-water crustaceans for them, so they were offered the expressed stomach-contents of gorged female ticks—*Rhipicephalus simus*—taken from a dog. A few fed once or twice but the majority refused, and all buried themselves in the mud.

On June 11th, the larvæ from A were transferred from mud to clean river-sand and water, and given freshly killed mosquito larvæ. They fed on these readily and grew apace, though at greatly varying rates.

The larvæ in B were also given mosquito larvæ from June 11th, but they refused to feed, and the mud in which they were living was several times allowed to dry up. On July 11th they were placed in clean river-sand and water, and at once began to feed and grow.

On July 19th the writer returned to Khartoum and, owing to the difficulty in obtaining mosquito larvæ, changed their diet to freshly killed and bruised earthworms. They did not take readily to this food, and some died, while others disappeared from their basins. At the time it was thought that they had become cannibals, but eventually it was found that they were being taken by mice. The stock of larvæ from A and B had by this time become reduced to one, which appeared to be full grown, and so was killed and preserved.

On July 26th the larvæ from C were transferred to clean river-sand and water. It was then fifty-seven days since they had emerged from eggs, and they had spent a great part of that time in a dry cake of mud. Occasionally this mud had been moistened, and food offered them, but they had very rarely taken it. Most of them were alive, but with the exception of a few which were slightly larger than when just hatched, they had not grown at all. They now, under more favourable conditions, fed readily on a mixed diet of earthworms and mosquito larvæ and grew, some rapidly, others more slowly. On September 3rd–4th one pupated, lying on the surface of the sand, partly submerged in water, and six days later gave rise to an adult female.

By October 18th several more had completed their life cycles, and on that date, as the writer was proceeding to England on leave, the remaining ones were killed and preserved.

All those that pupated, did so on the surface of the sand, some high and dry, others half in and half out of the water. Probably, under more natural conditions, the pupal stage would be passed buried in the soil—the structure of the pupal case seems to indicate this.

The average pupal period was from six to eight days.

The *egg* is spindle-shaped, about 1·15 mm. in length and white in colour, becoming darker as the embryo within develops.

The mature *larva* when fully extended measures about 13·5 mm. Colour, white with a greyish tinge. Mandibles dark brown to black, serrated. On the anterior third of each abdominal segment except the eighth is a ring of pseudopods, eight in each ring—two dorsal, two lateral and four ventral—except on the first abdominal segment, where the two dorsal ones are wanting. On the second abdominal segment the two dorsal pseudopods are very small. The pseudopods are largest on the third, fourth and fifth abdominal segments, and are always more developed on the ventral than on the dorsal surface. Each pseudopod bears a crown of colourless spines or hooks, and there are patches of dark spines between the pseudopods. The spines on the dorsal sections of the rings on the first and second abdominal segments are dark. The anus is situated ventrally, at the base of the eighth segment, and is fringed with blackish hairs. The siphon-tube consists of two segments, and, when exserted, is as long as the eighth abdominal segment.

The *pupa* is from 12 mm. to 15 mm. in length and at first yellowish white in colour, becoming darker as it nears maturity. The eyes show plainly through the pupal case as dark greenish purple. The empty pupal case is yellowish brown, the thoracic tubercles and the spiracles being darker than the surrounding parts. On the apical third of the second abdominal segment is a fine ring of backwardly pointing spines. Similar but broader rings, bearing longer and stronger spines, are on the third, fourth, fifth and sixth abdominal segments, and one of intermediate breadth on the seventh abdominal segment. The eighth abdominal segment terminates in a coronet of six teeth, in colour shining brown, becoming darker at the tips. The dorsal pair are smallest and close together, the ventral pair next in size and wider apart, and the lateral pair longest and arising from almost the same level as the dorsal pair. Ventrally placed to this coronet of teeth are two rows of small teeth, from two to four in each row, together forming an interrupted transverse row. These teeth are of unequal size and vary in their relative sizes in different specimens.

Tabanus tæniola, Palisot de Beauvois.

This is the most common and most widely distributed Tabanid found in the Anglo-Egyptian Sudan, and is the one most frequently accused of causing the death of camels. On the White Nile it occurs as far north as Ducim, and stray specimens, brought in by cattle, have occasionally been taken in Khartoum. Often it will board a river-steamer, and being, like other seroots, a vicious bloodsucker, will drive any animals travelling on the barges nearly frantic with pain. It will follow cattle and other animals long distances : on one occasion, after walking straight inland from the river for five hours without seeing a single seroot of any kind, numbers of this Tabanid in company with *Tabanus diteniatus*, Macq., were found attacking a buffalo which they had doubtless followed from some fly-belt near or through which the animal had passed. Males are rarely seen, though single specimens will sometimes board a river-steamer, and early in June 1909 some twenty or thirty of this species and the very similar *Tabanus variatus*, Walk., were noticed on flowering shrubs by Khor Felus, Sobat river.

Gorged females were taken in May on cattle grazing near Bor, and placed in a breeding-cage with a dish containing grass and weeds growing in mud and water. They were fed on sugar and water, and a few batches of eggs were obtained. A single egg-batch was taken in May on a blade of grass overhanging a dried up water-pool near Kanissa wood-station, and a number of egg-batches were collected early in July from grasses and weeds overhanging rain-pools at Gebelein.

The eggs are placed by the female fly on the upper side of a blade of grass or some similar plant, and, with the exception of the single batch taken at Kanissa wood-station, all those found were overhanging water. An unfinished egg-batch in plan resembles an arrow-head. The eggs are closely applied to each other and left bare, so the batch can easily be seen when freshly laid, owing to its shining white to yellowish white colour. Prior to hatching the egg-mass becomes darker.

The eggs obtained in the breeding-cage were laid on May 24th–25th, and hatched on May 29th. The larvæ were placed in glass basins containing mud, growing grass and water, and were offered the expressed stomach-contents of female ticks—*Rhipicephalus simus*—taken from a dog. They fed readily on this until June 11th, when they were placed in clean river-sand and water, and their diet changed to mosquito larvæ. These mosquito larvæ were either killed, or laid living on the wet sand out of reach of the water, in which position the Tabanid larvæ were able to kill them. In water the mosquito larvæ were too active to be caught. On July 16th their food was changed again to freshly killed and bruised earthworms, and these they also eat readily. While still young they became vicious cannibals, and consequently each larva had to be given a separate dish. They were brought to

Khartoum on July 19th, and a few days later it was noticed that the majority were not taking their food. They were then nearly, if not quite, full grown, so it was thought that they had buried themselves in the sand prior to pupating. A careful search, however, revealed the fact that they had disappeared, and it was not until later that mice were identified as the cause of the loss. The two remaining larvæ were then killed and preserved. It is possible, therefore, that the larva described below is not quite mature.

The larvæ of *T. taniola* are more active and ferocious than those of *T. par*, vigorously attacking any other larva with which they may come in contact. They have not, however, the power possessed by *T. par* of lying dormant in the soil for at least fifty-seven days if the conditions are unfavourable for their development.

The *egg* is spindle-shaped, about 1·75 mm. in length, and, when first laid, white in colour. It becomes darker as the embryo within develops.

The *larva* when fully extended measures about 29 mm. Colour white to greyish white. Mandibles black. On the anterior third of each abdominal segment, except the eighth, is a ring of pseudopods, eight in each ring—two dorsal, two lateral, four ventral—except on the first abdominal segment, where the dorsal pair is wanting. On the second abdominal segment the dorsal pair is very poorly developed. The ventral pseudopods are always larger than the dorsal. Each pseudopod bears a crown of colourless spines or hooks, and between the pseudopods there are also spines or hooks, often darker in colour, and forming a continuous ring. The anus is situated ventrally at the base of the eighth abdominal segment and is edged with dark hairs. On either side of the anus is a patch of dark hair, roughly kidney-shaped, and beyond each patch, laterally placed on the segment, are two small round spots of dark hair. The siphon-tube consists of two segments, and when exserted is shorter than the eighth segment. The whole surface of the larva is more or less shiny, with varying longitudinal striation, the areas bearing very fine striæ being markedly duller than the rest. The prothorax has the dorsal area smooth in the anterior two-thirds and rather coarsely striate posteriorly; the ventral area is almost entirely smooth and divided in two by a median furrow; the two lateral areas are finely striated in the basal third and more coarsely so in the anterior parts. The mesothorax has the dorsal and ventral areas smooth and shining in the anterior two-thirds, and rather coarsely striate posteriorly, the ventral area having no furrow; the lateral areas are a little more finely striate than those of the prothorax, and there is a rather broad dull non-striated band at both the anterior and posterior margins. Similar dull bands occur on the metathorax and the abdominal segments, but completely encircling the segment. The abdominal segments 1 to 7 have the dorsal and ventral areas moderately shining, and the striation is rather coarser and irregular; the lateral areas

appear much duller, owing to the extreme fineness of the striation. On the 8th abdominal segment the striæ are moderately well-marked and of similar appearance on all the faces.

A Natural Enemy.

From an egg-mass of *T. tæniola*, taken at Gebelein, numbers of a small Hymenopteron were bred. This has not yet been identified, but is figured in the accompanying plate, together with the parasitised egg-mass showing the exit-hole of the parasites.

EXPLANATION OF PLATE IX.

Fig. 1. *Tabanus tæniola*, P. de B., ♂.
2. „ „ „ ♀.
3. Full-grown larva of *T. tæniola*.
4. Egg-mass of *T. tæniola*, with Chalcid parasites.
5. Young larva of *T. tæniola*.
6. Young larva of *Tabanus par*, Walk.
7. Egg-mass of *T. tæniola*.
8. Egg-mass of *T. par*.
9. *Tabanus par*, Walk., ♂.
10. „ „ „ ♀.
11. Larva of *T. par*, almost full-grown.
12. Anal segment of pupa of *T. par*.
13. Pupa of *T. par*.

A. J. Engel Terzi *del.*

TABANUS TÆNIOLA, P. DE B., AND T.PAR, WALK.

A SHORT SURVEY OF THE MORE IMPORTANT FAMILIES OF ACARI.

By Dr. A. C. OUDEMANS.

Mites or Acari belong to the class Arachnoidea, which also contains the Scorpions, the Spiders, the minute False-Scorpions, the long-legged Field Spiders and some other curious eight-legged creatures. They are at present considered as a degenerating branch of the Arachnoid trunk. Their larvæ are six-legged, their nymphs eight-legged, but deprived of genital apertures.

Apart from the Ticks (Ixodoidea), mites have been generally very much neglected by collectors and systematists alike; but seeing that they comprise a considerable number of species of undoubted economic importance, it has seemed desirable to call attention to them by this brief account of some of the more striking forms. A fuller investigation of their habits and life-histories, especially as regards tropical species, is certain to yield much information that is likely to be of both practical value and scientific interest.

The Acari fall into the following natural groups :—

(1) Notostigmata.—A group of most interesting creatures of about two

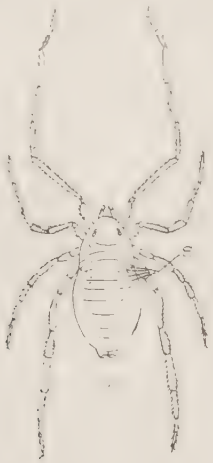


Fig. 1.—*Opilioacarus segmentatus*, With; female; dorsal side; S=stigmata. Copied from With, in Vid. Medd. Nat. Foren. Kjbhvn., 1904, tab. 1.

to three millimetres in length, with hard integument, and resembling somewhat the well known Field Spiders. It is still doubtful whether they are Acari or not. They breathe by four pairs of dorsal breathing-openings or

stigmata (hence their name) in the first, second, third and fourth abdominal segments. The legs on each side are contiguous. Hitherto they have been found only under stones in the circum-Mediterranean countries.—Mites may generally be caught by means of a small moistened paint-brush. They should be preserved in small glass tubes filled with alcohol. Into the tube insert a small label, on which should be noted, with black pencil or Indian ink, the locality, date, collector's name, and the conditions of capture or name of the host.

(2) TETRASTIGMATA, or HOLOTHYREOIDEA, are quickly moving ACARI, with brown, hard and shining integument, and as large as Lady-Birds (COCCINELLIDÆ). The upper surface is formed of a single shield-like plate; hence the name of HOLOTHYREOIDEA.

As is suggested by the alternative name of TETRASTIGMATA, these creatures are characterised by two pairs of dorsal stigmata, of which one pair is situated on the dorsal side, behind the line of insertion of the fourth pair of legs, whilst the other pair lies in the ventrally sufflexed margins of the dorsal shield or carapace, outside of the third pair of legs; being thus apparently, though not really, ventral in position (fig. 2). The legs on each side are contiguous.—Hitherto they have only been found under stones or on the under surface of dead leaves in the following islands: New Guinea, Ceylon, the Seychelles and Mauritius.

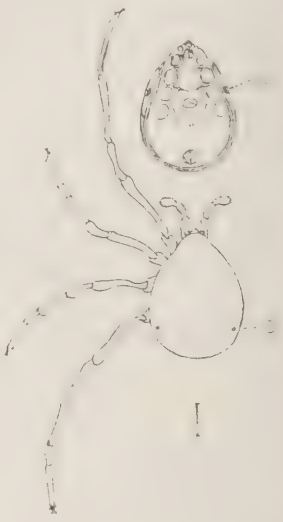


Fig. 2.—*Holothyreus longipes*, Thor.; male; dorsal and ventral side; S = stigmata.—Copied from Thorell, in Ann. Mus. Genova, xviii. 1882, tab. 4.

(3) METASTIGMATA, or IXODOIDEA (Ticks), are generally oval in shape, of varying colours, dorso-ventrally compressed, and slow in their movements; their stigmata lie, with a few exceptions (of which fig. 4 is a good example), behind the fourth pair of legs, as shown in figure 3; hence the name of METASTIGMATA. They occur as parasites, especially on mammals, less often on reptiles and birds, and rarely on toads or large spiders; but they also pass a part of their life free on low herbs, or among dry and decaying leaves.—Ticks are essentially blood-suckers, and their mandibles resemble in some measure a pair of boat-hooks with two or more hooks; they lie in a sheath and can be protruded and retracted. The first joints, or *coxæ*, of the two maxillæ are fused together, forming a flat rasp, which has its teeth on the ventral surface (see fig. 3, underside). The mandibles and maxillicoxæ together form the

rostrum, which is inserted into the host. The four remaining joints of each maxilla form together the (maxillary) palp ; the two palps are more or less excavate on the side toward the rostrum (see fig. 3, ventral side), thus forming a sheath wherein the rostrum is secured during the periods that the

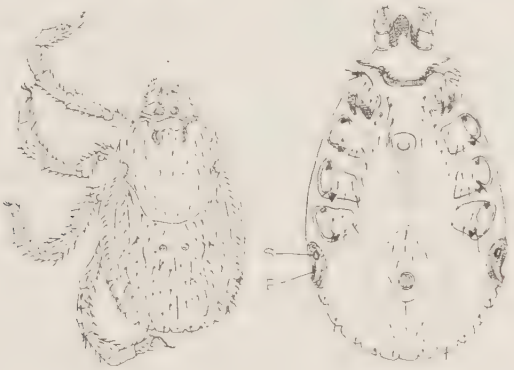


Fig. 3.—*Rhipicephalus sanguineus* (Latr.); female; dorsal and ventral side; S=stigma; P=peritrema.—Original.—**A noxious species.**

creature lives free. The eight legs are stout, ending in two strong claws, and are placed contiguously on each side.—As is shown in fig. 4 (ventral side), the genital aperture lies far forward. During copulation the ventral surfaces of the two sexes are apposed. As soon as the female is impregnated it gorges itself with blood from its host and becomes enormously distended,

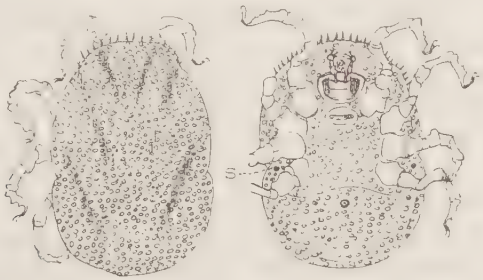


Fig. 4.—*Ornithodorus moubata*, Murray; female; dorsal and ventral side; S=stigma. Copied from Doflein, Protozoenkunde, 1909.—**A noxious species.**

sometimes even attaining the size of a hazel-nut. It then loosens its hold and falls to the ground, where it seeks shelter under stones, dead leaves, etc., for the purpose of ovipositing. In fig. 3 (dorsal side) it will be observed that the female has on its neck, behind the palps, two dull patches. Out of these patches grow two white or transparent sausage-shaped organs, which

bend over the creature's head towards its genital aperture, where they seize each egg as it is extruded and carry it back over the head to the dorsum. Within a few days the female is thus covered with eggs, and then dies.—The larvæ, as soon as they hatch, climb upon low herbs, till they reach the top of a leaf, to which they cling with their four hind legs, whilst waving their fore legs in the hope of grasping a host.—The IXODOIDEA are divided into two families, viz., the ARGASIDÆ (fig. 4) and the IXODIDÆ (fig. 3). The former have a leathery and more or less rough skin, and the stigmata lie between the third and fourth pairs of legs. As they attack men by night, they are sometimes mistaken for bed-bugs (CIMICIDÆ). The true ticks, however, have a hard, smooth, shining, often brightly coloured skin, and the stigmata are behind the fourth pair of legs. The females have only the fore part of the dorsum shielded (fig. 4), while in the males the shield covers the whole upper surface.

From an economic point of view both ARGASIDÆ and IXODIDÆ are most noxious creatures, the former being the disseminators of relapsing fever in man and a fatal disease in poultry, while the latter are responsible for about half-a-dozen dangerous diseases affecting various domesticated animals. When the creatures are attached to the skin of a host, a drop of chloroform, or ether, or benzin will soon force them to loose their hold. It is important that all stages of development should be collected, and the ticks from two different hosts should *never* be placed in one tube.

(4) MESOSTIGMATA, or PARASITOIDEA (Insect-Mites), are generally less than one millimetre in length, oval in shape, yellowish brown in colour, often well chitinised, more or less dorso-ventrally compressed, and more or less quick in their movements. Their breathing-openings, or stigmata, lie between the third and fourth pairs of legs (see fig. 5), hence the name of MESOSTIGMATA. Usually a long air-containing tube, called the *peritrema*, is annexed to the stigma; its signification is unknown. They prey upon creatures smaller than themselves, especially other Mites, Pauropods, Spring-tails, etc.: so that in many cases they are of direct service to man by destroying other noxious species, such as the mites of the genus *Tetronychus* (see below, p. 113), which cause damage to various cultivated plants. But there are also many species which are parasitic upon birds, bats and other mammals; *e. g.*, the species, represented in fig. 6, which sucks the blood of fowls and cage-birds. Hence it comes that they live literally everywhere: among dry and decaying leaves, in moss, among grass, upon or beneath the bark of trees, on the undersides of leaves, on mammals and birds, in groceries, etc. They often use flying insects, such as beetles, bumble-bees, etc., as a means of transport to reach better conditions, and have thus erroneously been supposed to be truly parasitic upon insects.—The mandibles of the predaceous MESOSTIGMATA end in pincers, resembling the claws of a lobster, and can be protruded and

retracted, in the same way as in the METASTIGMATA. Those of the blood-sucking MESOSTIGMATA are lancet-shaped. The mandibles are covered

Fig. 5.—*Leiulus truncatus*, Oudms.; female; dorsal and ventral side; S=stigma; P=peritrema.—Original.—**A useful species.**

dorsally by the *epistome*, the anterior edge of which is characteristic for almost every species. This epistome is fused with the maxillæ on both sides, forming thus a *camerostome* around the mandibles. The palps are filiform.

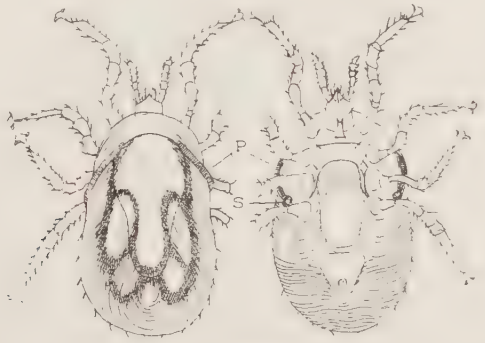


Fig. 6.—*Dermonyssus gallinæ* (de Geer); female; dorsal and ventral side; S=stigma; P=peritrema.—Copied from Mégnin, Les paras. et les malad. paras., tab. 1; 1880.—**A noxious species.**

The legs are generally slender, and placed contiguously on each side; the second pair of legs is generally thicker in the males. The genital aperture in both sexes lies far forward; in the males before the sternal shield, in the

females between the sternal and genital (striated) shield (figs. 5 & 6). The sperm is packed in a minute vesicle or spermatophore in the shape of an old-fashioned purse. The male effects impregnation by grasping one of these spermatophores with his own mandibles and placing it within the genital aperture of the female.

It is superfluous to mention here the families into which the group is divided. We need only draw attention to the LÆLAPIDÆ, many species of which are our friends or auxiliaries, as they devour all kinds of mites which are noxious to cultivated plants (fig. 5); and to the DERMONYSSIDÆ, many species of which infest our birds (fig. 6) and occasionally even mankind.

The MESOSTIGMATA are easily collected by sieving decaying leaves, by drawing a net over low herbage or grass, by brushing dead birds and small mammals, by inspecting with a magnifying glass the underside of leaves, the bark of trees, etc. They should be picked up with a soft moistened paint-brush and should be preserved in alcohol.

(5) PARASTIGMATA, or UROPODOIDEA (Stalked Mites), are always smaller than one millimetre, almost circular or oval in shape, light to dark brown in colour, ventrally almost flat, dorsally usually convex, and slow in their movements.—Their stigmata lie between the second and third pairs of legs,

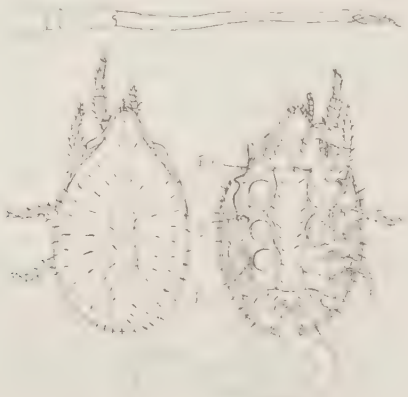


Fig. 7.—*Uropoda africana*, Oudms.; deutonymph.—To the left: dorsal side, through which the extremely long mandibles are discernible (only one is delineated). To the right: ventral side; S=stigma; Pe=peritrema; Pi=leg-pits; St=stalk. Above: mandible.—Original.—**Useful species.**

and a long serpentine air-containing *peritrema* is always present. The dorsal view in the accompanying figure of *Uropoda africana* (fig. 7) indicates the position of one of the very long exsertile mandibles, when completely withdrawn within the body. These nipper-like mandibles enable the mites to seize their prey at some distance. Their food consists usually of other mites

still smaller than themselves, and as these are for the most part injurious to plants, the PARASTIGMATA must be considered as useful organisms.—They are to be found everywhere, especially among low herbs, grass and decaying leaves, but also on the undersides of growing leaves, which often swarm with noxious mites. Their biology and anatomy are almost the same as those of the foregoing group, to which they are closely related, with this exception, that they do not occur on mammals or birds, nor in groceries. When the nymphs (eight-legged immature stage) use Insects as a means of transport (see above, section 4), they attach themselves upon them by means of a pellucid elastic stalk, which is formed by a secretion from two stalk-glands, flanking the anus ; hence the name of UROPODOIDEA, or Stalked Mites. The legs are short and can generally be fitted into depressions or pits on the ventral side of the body (fig. 7). If the mites are found attached to Insects either the whole insect should be preserved in spirits, or the mites may be carefully scraped off with a small knife and preserved alone.

(6) HETEROSTIGMATA are minute, transparent, rarely rose or orange-coloured, extremely weak creatures, with stinging and sucking mouth-parts. As the males lack stigmata, the name of HETEROSTIGMATA is proposed for this group. Those of the females are situated between the first pair of legs

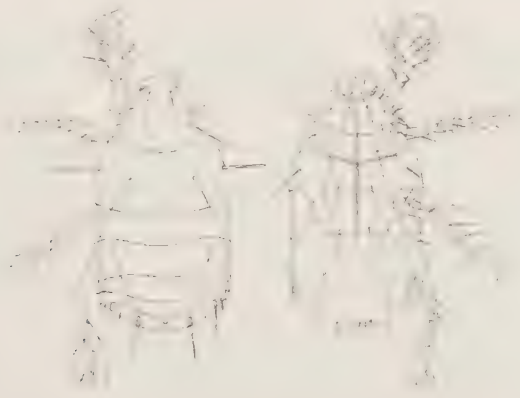


Fig. 8.—*Pediculoides spinosus* (Kramer) ; female ; dorsal and ventral side ; S=stigma. Original.—**Noxious species.**

and the maxillæ. Their eight legs are placed in four groups of two.—They all suck plant-juices ; so they are, if they occur in abundance, which is often the case, exceedingly noxious to cultivated plants, and if they have the opportunity to crawl upon men, they cause a most insupportable itching and redness of the skin (erythema).—The pregnant females become enormously distended. They exhibit an anatomical peculiarity in possessing what are

known as *pseudostigmata*, i. e., a pair of more or less cup-shaped organs in the neck, out of which emerges a sense-hair (in this case often club-shaped), called the *pseudostigmatic organ*.—Sometimes they migrate by attaching themselves to the hairs of small mammals (rats, mice, moles, weasels) or flying insects, for which their fore-legs are specially adapted. When found on animals they may be picked up with a moistened paint-brush; but if they occur on leaves, or ears of corn, the portion of the plant should be cut off and placed bodily in spirits.

(7) Stomatostigmata is the name of a small group of Acari, found among dead or decaying leaves, on which they apparently feed; for their mandibles are very short, but stout, and not protrusive. Their body is well chitinised and therefore more or less brown in colour. The arrangement of the legs is very anomalous, all the coxæ being approximated. The presence of two pairs of *pseudostigmata* seems to show a remote relation to the foregoing group. Their size is less than a millimetre, and their stigmata lie between the first and second pairs of mouth-parts. Their movements are slow. Hitherto they have only been found in the Northern Hemisphere.

Fig. 9.—*Labidostoma denticulatum* (Schrank); female; dorsal side and mandible; S = stigma; P=peritrema.—Original.

(8) To the large group of Prostigmata belong various kinds of Acari, more or less related to one another. They vary from one-fifth to ten millimetres in length. With only one or two exceptions they are weak creatures, being white, yellowish, rose or red in colour, rarely green or black. Their stigmata, or the rudiments of these spiracles, lie between the mandibles and the *epistoma* (a more or less prominent frontal lobe). Their food consists of plant-juices, blood, dead or living vegetable matter, or other smaller animals; the mouth-parts varying according to the diet. The presence of one or two pairs of *pseudostigmata* shows their relation to the five foregoing groups. The legs are generally placed in four groups of two. This group is readily divided into three sections.

(*a*) Prostigmata Eleutherengona are so called because their larvæ are, with only a very few exceptions, free living. Hereto belong, among others, the following families:—The Anystidæ, or Spider Mites (fig. 10), are swiftly running carnivorous Mites, closely resembling minute spiders, and of a red colour; they often occur in our houses, especially in garrets, but also on different plants; and as they prey especially on Mites, which in our

houses are at least troublesome, and on plants noxious, these creatures are very useful.—The PTERYGOSOMIDÆ, or Gecko Mites, are flat, orange, red or crimson coloured parasites, infesting Geckos.—The TETRONYCHIDÆ, or

Fig. 10.—*Tarsotomus parietinus* (Herm.); female; dorsal side; S = stigma.—Original.

A very useful species.

Spinning Mites (fig. 11), are slowly moving, green, yellow, orange or red creatures, which are exceedingly noxious to plants, as they suck their juices and increase considerably in favourable seasons. The red species are commonly known as "Red Spiders" in Germany and in America. They spin beautiful bowers in the angles of the leaf-nerves, but when they are in great quantities and the nights are long and cold, they spin together an extremely fine and shining tissue which envelops whole branches, twigs and leaves. Their legs terminate in four nail-shaped claws; hence the name of *Tetranychus*.—The CHELETIDÆ are quickly running voracious creatures with enormous prehensile maxillary palps (fig. 12). As they suck to death all kinds of mites, noxious to our plants and to our victuals, we must reckon them among our best friends. Like the foregoing Family they lack stigmata, but possess long membranous peritremata.—The MYOBIIDÆ, or Mouse Mites (fig. 13), are sluggish white creatures, which only suck lymph, and may be in some instances very troublesome to small mammals, including bats, as they attach themselves with their lancet-shaped mandibles preferably on tender parts of the skin, *e.g.* the eye-lids, lips, arm-pits, etc.—The BDELLIDÆ, or Snouted

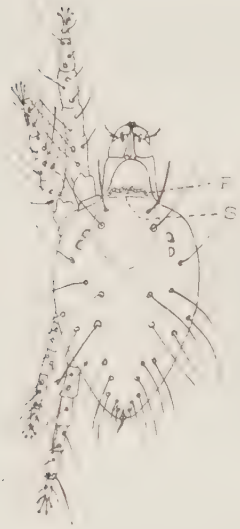


Fig. 11.—*Tetronychus carpini*, Oudms.; dorsal side; P = peritrema; S = closed stigmata.—Original. **A species very noxious to plants.**

Fig. 12.—*Cheletes eruditus*, Schrank; a cosmopolitan species; female; dorsal side; P = peritrema; S = closed stigmata.—Copied from Oudemans. in Tijds. Ent. v. 46, 1904, tab. 13.—**Useful.**

Fig. 13.—*Myobia affinis*, Poppe; female; dorsal side; S = closed stigmata; P = peritrema.—Copied from Mégnin, Les paras. et les malad. paras., t. 24: 1880.

Fig. 14.—*Bdella rubra*, Lam., dorsal side; S = stigmata.—Original.—**Useful.**

Mites (fig. 14), are generally slowly moving, but occasionally quick-running, predaceous creatures, usually of a red colour, and feeding on all kinds of soft-bodied Mites, which are to be found on plants and under the bark of trees.

(*b*) Prostigmata Parasitengona are so called because the larvæ are parasites, whereas the nymphs and adults are predaceous. Their very interesting, red-coloured larvæ are often to be found infesting gnats, water-bugs, water-beetles, all kinds of land-beetles, bugs, grasshoppers, spiders, frogs, birds, bats, and small mammals. In many instances they have no economic significance, but as in some cases they cause the death of mosquitoes and other noxious insects, they must to that extent be considered beneficial.

A figure is given here of one of the grasshopper-parasites (fig. 15). In hot

Fig. 15.—*Euthrombidium trigonum*, Herm.; larva; dorsal side.—Copied from Berlese, Ordo Prostigmata, tab. 13, 1893, a little altered.—**Useful.**

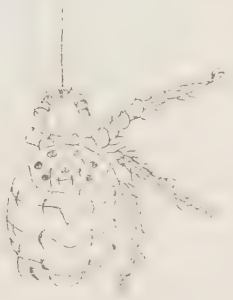


Fig. 16.—*Hydryphantes ruber*, de Geer; larva; dorsal side.—Copied from Oudemans, in Tijds. Ent. v. 46, tab. 1; 1904.—**Useful.**

summers, especially during the harvest time, they may abound, and in this instance they may be exceedingly troublesome to man. Thus in the Guianas the "batata-mite," in Mexico the "tlalzahuatl," in France the "rouget," in England the "harvest-mite," in New Guinea and Celebes the "gonone," are well known plagues. They burrow into the skin and cause intolerable itching and painful little blisters. To this section belong the slowly moving, generally scarlet and velvety, Harvest Mites (Thrombidiidæ), which live free, preying on smaller weak creatures, gnats and flies, and living on the ground, on trees, or on herbs: it includes also the well known, generally globular, red or green Water Mites (Hydrarachnidæ); and finally the quickly running, red or brown coloured Tufted Snout Mites (Erythræidæ).

(*c*) Prostigmata Pleuromerengona are so called because the limbs are planted at the sides of the body and not beneath it, being an adaptation to a marine life. They occur not only near the shore, but also at great depths, generally living among seaweed, upon which they crawl with facility. When the waves sweep them upwards from their natural haunts, they spread out their limbs, which in many cases are provided with beautiful horizontal fans, so that they gently sink again to the bottom. They suck both animal and vegetable juices, and may be obtained by means of fine-meshed scoop-nets, or by cautiously picking them out of a handful of seaweed placed in a bowl with sea-water.

(9) Octostigmata, or Oribatoidea (Beetle Mites), are generally oval or circular in shape, less than one millimetre in length, light or dark brown in colour, ventrally more or less flat, dorsally more or less convex, with a somewhat hard and shining integument (hence the name Beetle Mites), and slow in their movements. The stigmata are generally eight in number, and lie in the soft skin of the acetabulum or socket, which holds the basal joint (coxa) of the leg. The creatures live free among dead and decaying leaves, among grass, in mosses and lichen, upon and beneath the bark of trees, and very often shelter under stones; they are generally vegetarian in their diet, feeding especially on the hyphæ, mycelium and spores of fungi; therefore their mandibles are not protrusive and are provided only with short claws. But there are a few species (*Pelops*) which have long exsertile mandibles, so that acarologists suspect them of being predaceous. A pair of pseudostigmata seems to indicate a relation to the foregoing groups, but in the majority of the species the legs are placed in two continuous rows, one on each side. Of their pairing nothing is known. They resort to the well known and widely distributed trick of shamming dead on the approach of danger. It has often happened that a roof of a house, or the trunks of the trees of an orchard have been found to be swarming with Beetle Mites, to the great fright of the inhabitants or of the owners; but it has been proved that the creatures are perfectly harmless.

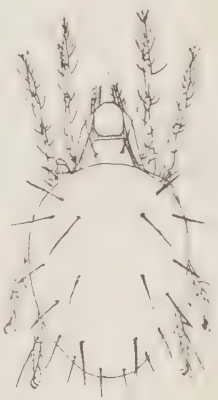


Fig. 17.—*Eremæus hesseï*, Oudms.; an African species; dorsal side.—Copied from Oudemans, in Tijds. Ent. v. 45, tab. 12; 1903.

(10) Astigmata, or Acaroidea, is the name of a large group of generally minute creatures (*akarēs* = indivisible); they are weak, white or pale, generally oval in shape, rarely compressed, but plump and more or less cylindrical. All are slow in their movements, and they lack stigmata.

Many live free and feed on fresh or dead animal or vegetable substances; others are parasitic on mammals or birds; others feed only on hairs or feathers. Hence they are found literally everywhere. Generally their mandibles are short, not protrusive, and end in short and stout nippers, like those of a lobster. Their palps are generally filiform and short. Their legs are short, in some instances extremely short, or even rudimentary, and are arranged in four groups of two each, like in the foregoing group, to which they are very closely related. The female genital aperture is generally placed far forward, that of the male behind the middle of the ventral surface. The following curious facts are worth noting.

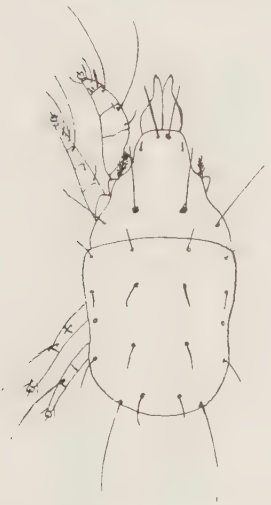


Fig. 18.—*Aleurobius africana*, Oudms.; female; dorsal side. Original.

Fig. 19.—*Sarcoptes equi*, Gerl.; female; dorsal side.—Copied from Mégnin, Les paras. et les malad. paras., tab. 9; 1880. **A noxious species.**

As in LEPIDOPTERA, the females, or rather the female deutonymphs, are provided with a special copulatory opening or projecting tube, and the males generally pair not with the mature females but with the deutonymphs. In these cases the nubile deutonymphs only develop into mature females after fertilization. To this group belong, among others, the following Families: the TYROGLYPHIDÆ (Cheese Mites), which may be found on all kinds of animal and vegetable victuals (fig. 18), in decaying leaves, in mosses, in mushrooms, etc. Sometimes they abound in houses, stores, churches, etc., swarming in such numbers as to cause considerable annoyance. In most of these instances they have been introduced in the so-called vegetable horse-hair (vegetable fibres from Halfa-grass and dwarf-palms), and soon disappear.

The Listrophoridæ (Hair-Clasping Mites) attach themselves to the hairs of small mammals by means of clasping organs, consisting of deformed maxillæ or legs. The Acaridæ, or Sarcoptidæ (True Itch Mites), burrow under the epidermis of their hosts (birds and mammals) with their extremely short mole-like feet and their short lobster-claw-shaped mandibles (fig. 19). They are liable to attack both human beings and domesticated animals, causing scabs and intolerable itching. The Feather Mites (Dermoglyphidæ and many other Families) live especially on birds, feeding only on feathers. In winter they often shelter in the quills, or, transformed into short-legged, weak, cylindrical bodies, they hibernate in the nostrils, the tracheæ and bronchi, or the lungs and air-sacs of their hosts. When these mites are discovered upon a bird, infected portions of the feather should be cut off and at once preserved in

Fig. 20.—*Chorioptes spathiferus*, Mégnin: female; dorsal side.—Copied from Mégnin, Les paras. et les malad. paras., tab. 18; 1880.—**A noxious species.**

Fig. 21.—*Demodex canis*, Leydig; female; ventral side.—Copied from Mégnin, Les paras. et les malad. paras., tab. 26; 1880. **Sometimes noxious.**

alcohol. The Psoralgidæ (False Itch Mites) never burrow beneath the skin, but merely pierce it with their conical mouth-parts (fig. 20); nevertheless they also produce scabs and intolerable itching. On our domestic animals, especially hoofed animals, they cause the well-known hoofscurf. Their legs are long.

(11) Lipostigmata, or Demodicidæ (Sebacic Mites), are very elongate club-shaped, transparent, extremely minute mites, which have eight very short mole-like feet on the "club" (fig. 21); this club contains only the

muscles of the mouth-parts and feet, the brain and the salivary glands. The tail-shaped body contains the entrails proper. They live in the sebaceous sacs and hair-follicles of all kinds of mammals, especially in the face. Rarely they cause scurfs. This is a very neglected group, and worthy of more attention. Parts of the attacked skin should be preserved in alcohol. The creatures lack respiratory organs, and most probably they are related to, or perhaps even an earlier stage of, *Psorergates simplex*, which also lives in sebaceous sacs (Family Cheletidæ, see above, p. 113).

(12) Zemiostigmata, or Tetrapodili, or Eriophyidæ (Gall Mites). They are elongate, transparent, minute creatures without respiratory organs, which they have entirely lost (hence the name of Zemiostigmata), and with only four anteriorly placed legs (fig. 22). Probably they are most nearly related to, or perhaps even an earlier stage of Tetronychidæ (see above, p. 113). They generally cause various kinds of "galls," excrescences and deformities of leaves, buds, twigs, etc., within which they live, and which are filled, or covered, with white hairs or down. A few species live free, but always on leaves, especially on the underside. The galls or deformities must be separated from the plant, then set aside in shadow, so that they may dry a little; then cut them into pieces, put them into a wide and short glass tube, closely corked, and placed in a remote corner of the room. After a time it will be observed that all the minute creatures have come together on the window-side of the tube. Uncork the tube, cautiously remove all the pieces, and fill it with spirits. As these mites are extremely delicate, never put the labels into the tube, but paste them outside.

Fig. 22. — *Eriophyes tenuis*, Nalepa; dorsal side of fore-part, and ventral side of entire creature.—Copied from Nalepa, Phytoptida, in Denk.Ak.Wien, 1891, tab. 1.

A MEALY BUG INJURIOUS TO THE LEBBEK TREES OF CAIRO.

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Entomologist to the Khedevial Agricultural Society.
With Appendices by Robert Newstead, M.Sc., etc., and Frank Hughes.

(Plate X.)

General.

In a sub-tropical city like Cairo it is most important that, so far as possible, the main streets be protected from the direct rays of a powerful sun by numerous and healthy shade-giving trees. For this purpose, the Lebbek (*Albizzia lebbek*) has been very extensively employed in Cairo, where it affords a welcome shade, as well as adding very considerably to the appearance of the streets. Until the summer of 1909, these trees have, on the whole, filled their parts quite satisfactorily. They had only one serious insect enemy to contend against, in the form of a longicorn beetle—*Xystrocera globosa*, Oliv. Hitherto this "borer" has been considered by far the most important pest of the lebbek, since its attacks, although comparatively slow in their effects on the life of the tree, are yet sure, and when extended over a period of years have caused no little mortality amongst the shade-trees of this city. During the past year the importance of this beetle has been, so far as Cairo is concerned, somewhat eclipsed by the depredations of a comparatively new pest—a mealy bug. This insect proves to be new to science, and is described for the first time in the appendix to this paper under the name of *Dactylopius perniciosus*, sp. n.

Under certain, but apparently somewhat special conditions, the seriousness of this insect as a shade-tree (lebbek) pest cannot be over-estimated. It does not merely cause temporary injury to the infested trees, but may actually destroy the "crown," if not the entire tree, in the short space of a few months. On the other hand, the lebbek beetle or "borer" takes, generally speaking, several years to kill a tree.

The lebbek mealy bug was first discovered in 1906 on some cotton plants growing in the garden attached to the laboratories of the Khedivial Agricultural Society, on Ghezireh Island. The insects were present in small numbers only, and did not show signs of increasing to any great extent. It seemed improbable that cotton, a plant grown as an annual, was anything more than a chance host-plant of this insect. Such proved to be the case. In 1907 it was traced to some lebbek trees growing in the road outside the

laboratory garden ; but although not difficult to find on the trees in this neighbourhood, the mealy bug was present in small and scattered colonies only. At this time, *D. perniciosus* was looked on as being an interesting creature, but not of any great economic importance. Later in the year

Fig. 1.—Healthy lebbek trees (*Albizzia lebbek*) growing on Ghezireh Island, Cairo.*

(August 1907) it attracted considerable attention, owing to the fact that on a few trees in Cairo it increased to such numbers and caused such serious injury that the Tanzim decided to cut the invaded trees right back to the trunk. They were treated in this manner with a view to preventing the

* All the illustrations used in this article are from photographs taken by Mr. F. C. Willcocks.—Ed.

spread of the pest to other trees ; but an examination made at the time by the author of this paper showed that the mealy bug was present, not only on other trees in the same street, but also in many other parts of the town.

The pest did not again become conspicuous until the summer of 1909, when in certain streets of the city it increased at an alarming rate and gave rise to the death of a large number of trees, and, in addition, caused loss and inconvenience in other directions. Its depredations during the past summer now entitle it to rank as a lebbek pest of the first importance ; but it is fortunate that this scale-insect only becomes at intervals sufficiently numerous to be injurious, and it is believed that one reason, if not the chief one, for its unusual increase is an unhealthy condition of its host-plant.

Food Plants.

In addition to the lebbek (*Albizzia lebbek*) and cotton (*Gossypium* spp.), *D. perniciosus* has been found on Christ's Thorn (*Zizyphus spina-christi*) and on the Sunt Tree (*Acacia arabica*).

The lebbek is an introduced species, but the date of its introduction into Egypt is not known. Sunt (*Acacia arabica*) is indigenous in many parts of Africa, including Egypt, and it may be the original host-plant of the mealy bug, from which it has spread to the lebbek. The Sunt is a very common tree in this country.

Distribution of the Lebbek Mealy Bug.

At present we possess a very scanty knowledge of the distribution of this pest. In Cairo it has appeared up to the present in most, if not all, of the streets in which lebbeks are grown. It occurs also on Ghezireh Island and the Gizeh side of the river Nile. The only other locality from which the species has been recorded is Marg, a village some ten miles from Cairo. No doubt further search will show it to be present in many other parts of Egypt.

There are no records to show for how long this species has been present in Cairo; probably it has been there for many years, although only discovered for the first time so recently as 1907.

Life-History and Habits.

The life-history of this insect has not been worked out in detail. From general observations made up to the time of writing, it appears to breed continuously throughout the year. Recently (January, 1910), after a spell of unusually cold weather, during which the thermometer in the screen on two nights registered several degrees of frost, colonies of females were found on lebbek trees in Cairo with well-developed ovisacs, containing

numerous eggs and a number of newly-hatched active larvæ. Females in earlier stages of growth were found at the same time. The increase of this pest is of course very much slower during the cold weather (November to March) than in the spring and summer months. From last year's experience one would gather that the most active period is from May to July or August.

The species is prolific, a large number of eggs being laid. Sufficient egg-counts have not been made up to the present to permit of a definite statement as to the average number of eggs laid by a female under normal conditions. In January of this year eleven hundred eggs were found in the ovisac of a

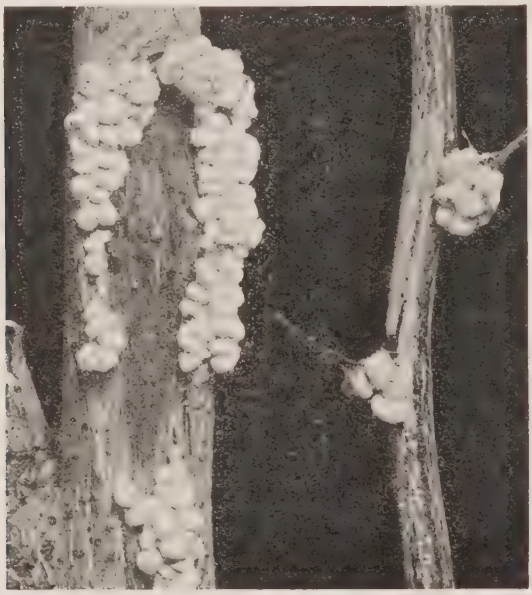


Fig. 2.—Colonies of the mealy bug (females with their ovisacs well developed) situated round the edge of a wound, and in the axils of leaf-petioles.

single female, which latter appeared to be still quite vigorous. Probably double this number of eggs may be produced under favourable conditions.

After hatching, the young larvæ settle down in large numbers on the twigs. They appear to be specially fond of crowding together in the axils of the leaf-stalks of the compound leaves (fig. 2); on the site of old leaf-scars; at the base of the flower-stalks; and on the growing points of the twigs (fig. 3). When numerous, they invade the leaves, fixing themselves on the petioles (fig. 4). They have also been found on the green seed-pods in the autumn. Another very favourite situation is on the callous tissue formed round the edge of a wound or surface exposed by the "lopping" of a

branch (fig. 2). Again, he insects are very frequently found at the base of the small shoots which sometimes grow out from the trunks of the trees.

So far we have no details as to the time elapsing between the hatching of the larvæ and the formation of the ovisac and subsequent oviposition ; nor as to the changes in the external appearance which takes place between these stages. The larvæ are sparsely covered on the dorsal surface with a white secretionary substance, which becomes more marked in the later stages and apparently corresponds to the segmentation of the body.

Fig. 3.—Growing point of lebbek attacked by the mealy bug.

When the globular ovisacs have developed, the insects impart a very striking appearance to the twigs and branches they infest. The latter appear to be covered with masses of pure white, somewhat felted, cotton-wool-like material. So marked is this appearance that writers in the local papers have been led to describe the attack of this pest as a kind of leprosy of the trees. The photograph (fig. 5) of twigs taken from the "crown" of a badly infested tree will explain this appearance better than a written description.

The nodular white masses on the side of the twigs should be noted ; they are formed by mealy bug colonies covering the sites of old leaf-scars.

The insects produce a large amount of sticky "honey-dew," which falls down on to the pavement below the trees, forming spots somewhat like raindrops. In paved streets one can readily detect an infested tree by the numerous honey-dew spots thus produced. Dust collects to such a degree over the site of the spots that the level of the pavement is perceptibly raised thereby. The honey-dew appears to be secreted more abundantly during the summer than at other periods of the year. Ants are very fond of this secretion, and visit the insects to obtain it.

Fig. 4.—Compound leaf of lebbek, showing colonies of the mealy bug on the leaf-petioles and elsewhere.

The males of *D. perniciosus* are by no means rare, but they do not appear to be in any way proportionate to the females, which far outnumber them. It is probable, therefore, that many of the females reproduce parthenogenetically.

The Appearance of the Infested Trees.

In the case of a bad attack of this pest, the whole crown of a tree may be killed in the course of a few months. The leaves turn brown, die and fall ; finally the twigs and minor branches die back. Infested trees which have

reached this stage appear as if they had been scorched by fire, but the crowns of such trees do not become completely defoliated. Many of the dead leaves and leaf-petioles are retained, and this in a very singular manner. The surface of the ovisacs of the females is somewhat adhesive, and this peculiarity is further increased by the honey-dew secretion. Dead leaflets, leaf-petioles and dead flowers, themselves already perhaps made sticky by the honey-dew, fall upon the mealy bug colonies and gradually accumulate over and round them, forming small masses of débris. These masses of leaf and other débris covering the colonies of the insects appear brown from

Fig. 5.—Twigs from lebbek tree badly infested with the mealy bug.

below, and are especially noticeable on and at the end of the twigs, giving to the attacked trees the very characteristic appearance shown below (fig. 6). These photographs should be compared with that of a healthy lebbek tree (fig. 1).

At the time when the mealy bug was most abundant, the trees were in full flower, so that the colonies of the insects frequently became almost entirely covered over by dead blossoms in the manner just described (fig. 7), reminding one somewhat of the mossy or Bedeguar Galls found on rose-bushes, formed by one of the Cynipidæ (*Rhodites rosæ*).

The protection afforded to the insects by the covering of dead leaves, etc., is very considerable; and it is almost impossible to reach the underlying insects with insecticides when protected in this way.

In the earlier stages of the attack, the effect which is produced on the

Fig. 6.—Lebbek tree in Chareh Kasr el Nil, attacked by *Dactylopius*. The entire crown of this tree has been killed.

foliage by the irritation set up from the numerous punctures made by the sucking tubes of the insects, is quite marked. The growing points of the twigs and the young leaves become twisted and malformed. The leaves, moreover, do not grow out normally but remain in a rather closely packed mass. In the case of one tree, this effect was particularly noticeable; the

Fig. 7.—Colonies of *Dactylopius* protected by a covering of dead lebbek flowers.

Fig. 8.—An earlier stage of the formation shown in fig. 7.

foliage of the crown did not expand fully but remained more or less bunched, so that the tree appeared as if suffering from the attacks of some fungus, allied to "witch-broom" disease.

Later in the year, if the insects invade the seed pods, these latter also become malformed; but such instances are unusual.

In July and August, one of the sooty mould fungi (*Meliola* sp.) is common on the honey-dew secretion, producing a blackish covering over the twigs and leaves of infested trees, and to some extent on the ovisacs of the females.

Methods of dispersal.

It has frequently been asked in what manner these insects spread from tree to tree, since in their active (larval) stages they are minute, fragile and destitute of organs of flight. In many cases there can be no doubt that the young larvæ migrate or spread from tree to tree by means of the interlacing twigs and branches of the crowns. The trees are frequently planted so close as to touch those on either side, and sometimes they even meet across the road. However, when the trees are not in contact but are separated from each other by considerable distances, we must seek other ways by which the pest extends its field of operations. Reasoning on what is known concerning the dissemination of the COCCIDÆ as a group, we may safely assume that birds, insects and wind each play a part in the dispersal of *D. perniciosus*. The grey crows (*Corvus cornix*) and sparrows (*Passer domesticus indicus*) are frequent visitors to the lebbeks, and it is more than likely that they sometimes carry from tree to tree parts of the egg-bearing ovisacs of the female mealy bugs, and also the young active larvæ, on their feet or bodies. The same may be said of some of the predaceous enemies of this pest. Infested twigs and leaves may also be blown from place to place and thus fresh colonies of the pest may be established.

The Infested Area.

The area in which the lebbek mealy bug increased to injurious proportions was approximately one square kilometre in extent. This area was bounded on the North by Chareh Boulak; on the East by Chareh Kamil and Chareh Abdin; on the South by Chareh Koubri Kasr el Nil; and on the West by Chareh Kochlak (Meidan Mariette Pasha) and Chareh Abbas. The pest was not equally injurious to all the lebbek trees contained in this portion of the city. The streets in which most damage occurred are as follows:—Chareh el Manakh, Chareh Kasr el Nil, Chareh Soliman Pasha, Chareh Emad el Din, Chareh Boulak, Chareh Kamil, Chareh Abdin, Chareh el Maghraby, Chareh el Madabegh, Chareh Gameh Charkasse, Chareh Mazloum Pasha. Of these streets, the first four suffered most noticeably. Chareh Taher, which lies just beyond the Eastern boundary mentioned, and Chareh Tewfik, outside of the Northern

boundary, were also badly attacked (Plate X). Occasional trees in other districts of Cairo were infested and seriously injured by *D. perniciosus*, but compared with the streets mentioned by name, the damage was insignificant.

The area in which the pest played such havoc is, generally speaking, the most modern part of Cairo City. During the past fifteen years the builder has been very busy, converting what was once a district of private houses with large gardens fronting on to the main roads, into a quarter closely built over with shops and big blocks of flats and business offices. No doubt the trees have been influenced by this change.

The following table illustrates in a marked degree the extent of the injury caused by this pest under certain conditions. It shows the number of lebbek trees which were badly infested with *Dactylopius* during the summer of 1909 in those streets lying within the area marked on the map (Plate X).

Table showing the damage done by the Lebbek Mealy Bug in the streets indicated on the Map (Plate X).

Name of Street.	I. Full Complement of Trees.	II. Total number of Trees seriously injured in 1909.	Percentage of Full Complement of Trees.	III. Number of Trees which have since died and been removed (Feb. 1910).
1. Chareh Kasr el Nil	194	86	*44 %*	37
2. Chareh el Manakh	106	83	*78*	62
3. Chareh Soliman Pasha	173	59	*34*	33
4. Chareh Emad el Din	173	50	*29*	15
5. Chareh el Madabegh	110	48	*44*	17
6. Chareh Koubri Kasr el Nil.....	230	45	*19*	28
7. Chareh Boulak	130	39	*30*	23
8. Chareh el Maghraby	101	38	*38*	26
9. Chareh Gameh Charkasse	90	36	*40*	17
10. Chareh Kamil and Chareh Abdin ..	88	24	*27*	6
11. Chareh Cheikh Hamza	78	19	*24*	12
12. Chareh el Bostane	139	18	*13*	10
13. Chareh Mariette Pasha	20	14	*70*	3
14. Chareh Mazloum Pasha	28	8	*29*	3
15. Chareh Abbas (west part)	223	18	*8*	15
16. Chareh Tewfik	62	13	*21*	3
17. Chareh Taher	47	12	*25*	0
Total	1992	610	*30*	310

Explanation of Table.

Column I.—These figures are of relative value only, since in most of the streets there are many young trees (about 5 years of age or under), as well as blank spaces; the trees which formerly occupied these positions having died from some cause or another. Young trees and blanks have been included in the estimate of the full complement of lebbek trees which should be present in each of the streets tabulated. The figures for each street must be taken as only approximately correct.

Column II.—Shows the number of trees in each street which were so severely attacked by the mealy bug during the summer of 1909 that they were cut back in the manner shown in fig. 9.

Column III.—Gives the number of "cut-back" trees which died subsequently and were removed between August 1909 and February 1910. The death of these trees may be considered as having been directly caused by the mealy bug.

The Tanzim Department, Ministry of Public Works, kindly supplied these figures.
It will be observed that 50 per cent. of the trees that were cut back eventually succumbed.

We are not in a position to attempt an estimate of the pecuniary loss which has accrued from the depredations of the mealy bug during the past year, as we have no data concerning the value of the trees killed by the pest. There can be no doubt, however, that the loss will prove to be a heavy one. The value of the trees already dead alone represents a sum of many thousands of pounds sterling, since we believe that as high a value as £25 is placed on the older trees. Presumably this sum is the capital value, and includes original cost, cost of planting and subsequent care and maintenance. The trees which were cut back, but are still living, have depreciated in value very considerably, and it is not unlikely that a number may die in the near future. Moreover, if replanting is decided on—as it probably will be, in the case of the principal streets—these crippled trees will be removed and must be reckoned as a loss. The cost of removing dead trees and the cost of replanting must be debited to the account of the mealy bug. On the credit side may be placed the value of the destroyed trees as timber.

Natural Enemies.

At present we have but a scanty knowledge of the parasitic and predaceous enemies of *D. perniciosus*.

Small parasitic Hymenoptera belonging to the family Chalcidid.e appear to play a very important role in the natural control of this pest. Three members of this family have been reared from the mealy bug. Two of these are quite common. One is a handsome little insect, with pale greyish green eyes; the vertex and frons of the head and the thorax bright orange to orange-red in colour. The abdomen is dark and covered, especially laterally, with lustrous silvery hairs. Legs dusky, shaded with grey. The antennæ

are rendered conspicuous by the dilated scape and the four terminal segments which are yellow. The male is smaller and more sombrely coloured.

The other species, if less pretty in appearance, is believed to be commoner and the more beneficial of the two. Not infrequently, entire colonies of the mealy bug are practically exterminated by this Chalcid. It is of a general yellowish brown colour, with darker brown shadings.

Fig. 9.—Chareh el Manakh as it appeared in August 1909, after the trees had been cut back.

The third species which has been bred from colonies of the mealy bug, is a very small, dark, highly metallic green Chalcid, with yellow legs and brown antennæ.

The identification of all three species has yet to be determined.

The predaceous enemies are represented by members of the orders Diptera, Neuroptera and Coleoptera.

The larvæ of a Cecidomyiid fly are not uncommon in and amongst the ovisacs of *D. perniciosus*. It is thought that they may feed on the ova. The larvæ are quite conspicuous, being coloured a bright orange-red, paling to orange towards the head. There is a dusky dorsal area. The ventral surface of the segments is provided with a transverse row of prominent fleshy tubercles.

The larva of a Neuropterous insect, *Hemerobius* sp., was also found preying upon the young stages of the *Dactylopius*. The adult is a pale sepia-brown insect.

The order Coleoptera is represented by three members of the family Coccinellidæ or lady-bird beetles. One species, *Exochomus nigromaculatus*, Goeze, is a handsome insect with shiny black elytra and an orange or orange-red head and thorax, the legs and venter being of the same colour. Unfortunately it does not appear to be very abundant and cannot therefore be considered of much importance as a natural enemy of the pest. The adults and larvæ of this species also feed on Aphididæ.

The most common Coccinellid of the three is a species of *Scymnus*. This beetle is small in size, measuring about 2 mm. in length and 1 mm. across the wing-covers. The head and thorax are of a reddish brown hue, covered with numerous short, fine, silvery hairs. The elytra are blackish to dark brown, paler at the margins, and conspicuously marked with dull ivory-yellow. There are numerous silvery hairs on the elytra. The legs are ferruginous. Both adults and larvæ feed on the immature stages of *D. perniciosus*, as well as on other scale insects and Aphididæ. The larvæ are yellow in colour and are completely covered dorsally and laterally with prominent, pointed, white, waxy processes, which give them a close resemblance to mealy bugs.

The third species is a small beetle measuring about 3 mm. in length and 2 mm. across the elytra. The head is black; the thorax black with pale margins. The elytra are of pale yellowish ivory colour with a conspicuous black trident-shaped marking, of which half is on each elytron. The larvæ have smooth and somewhat mealy skins. The pupa is bright ochreous brown densely covered with short, bristle-like hairs. This species has been found on one occasion only, feeding on a colony of the *Dactylopius*; it appears to be rare.

Methods of Control.

The control measures employed in 1909 by those in charge of the trees were as follows. Infested trees were headed right back to the main branches as shown above (fig. 9). The tree was then thoroughly scraped and brushed with a hard brush, and afterwards painted with a mixture of paraffin oil,

soap, lime and water. At this time it was hoped that the trees treated in this manner would throw out a fresh and clean growth and eventually again form normal crowns. A new growth was put out, but in many cases it died back before the autumn, as also did the main branches. The vitality of the trees appeared to be exhausted. A considerable number of trees treated in the above way retained their new shoots, but it seems rather doubtful whether they will ever make good trees again.

Drastic as this treatment was, there was little else to be done, since there was no spraying apparatus available and the trees had reached a state when the benefits of spraying would have been very uncertain. Moreover, spraying could only be carried on under considerable difficulties in Cairo, if at all. The cutting back of the trees only anticipated by a few weeks the ultimate result of the effects of attack by the mealy bug.

The young lebbeks were cleared of isolated colonies of the pest by the use of the paraffin, soap and lime mixture applied with a stiff brush. This treatment appeared to give satisfactory results.

In a note sent to the town authorities dealing with the question of the mealy bug, it was pointed out by the writer that in future it should be the aim of those in charge of the trees to prevent the mealy bug from again increasing to such numbers that the present drastic treatment should again become necessary.

This result could only be attained by improving the general health of the trees and keeping a careful watch over them in order to note any tendency on the part of the pest to increase. If it showed signs of unusual increase, then only by spraying with an insecticide could they hope to keep it in check. The insecticides recommended for trial were: paraffin emulsion, whale-oil soap, and distillate oils. These suggestions were, of necessity, tentative, since no previous work had been carried out in Egypt on these lines against any insect, similar in its nature and habits to *D. perniciosus*, attacking city shade-trees; nor, for that matter, in other countries, so far as the writer is aware.

It should be our object to destroy the larvæ and immature stages rather than the adult females, since the latter are well protected by a waxy covering. Moreover, as already pointed out, the colonies of females frequently become so well protected with dead leaves and other débris, that it would be difficult at this stage to reach them with a spray. Furthermore, in order to affect the females and their ovisacs, it is necessary to employ a penetrating wash, such as paraffin emulsion of 12–15 per cent. oil. Unfortunately, this strength has a very serious effect on the foliage of the lebbek, which appears to be particularly susceptible to burning by paraffin oil. The scorching effect can be lessened to some extent by the addition of naphthaline to the emulsion, but by no means entirely prevented. Even an emulsion containing 6 per cent. oil burns the leaves, whether spraying is carried out

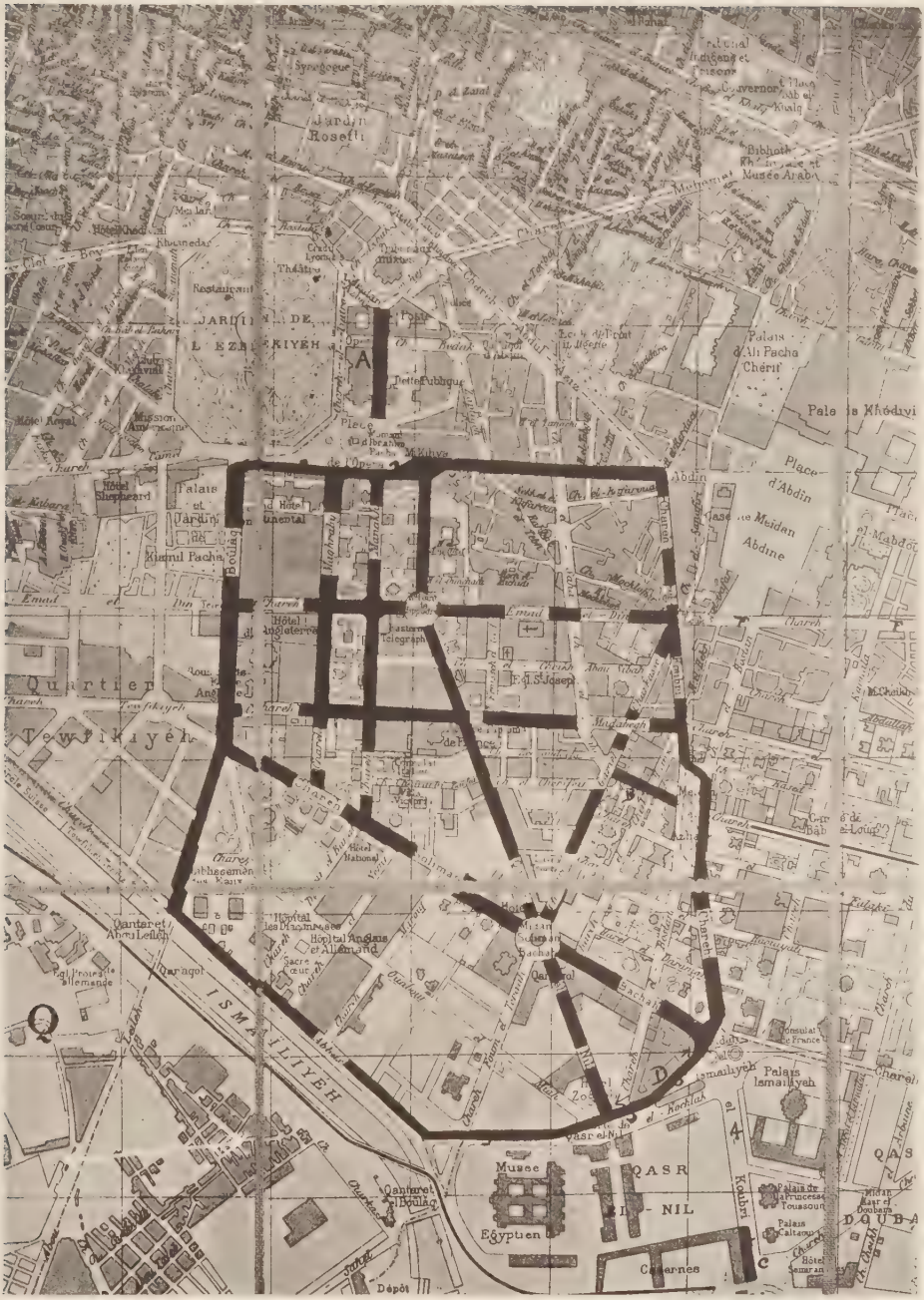
in bright sunshine, in the cool of the evening, or in the early morning. A 6 per cent. paraffin emulsion appears to give fair results against the larvæ, and a 12 per cent. strength has a considerable effect on the females and their ovisacs. However, time and other work did not permit of any careful and complete series of experiments being carried out during the summer of 1909 with paraffin emulsion, so it is therefore impossible to make any conclusive statements concerning the efficacy of this spray as a remedy for the lebbek mealy bug. A strong emulsion could very well be used in the early part of the year (end of February or March) at the time when the trees drop their leaves, for there would then be no risk of burning the foliage or young growth and a smaller quantity of the wash would be required. Moreover, the pest probably commences to become more active at this time.

It was suggested that for painting the trunks and branches of infested trees and also for young trees, an emulsion of paraffin and soap was to be preferred to an ordinary mixture of the two then in use. The addition of lime is certainly desirable since it acts as an indicator, enabling one to observe readily the thoroughness with which the painting is being carried out. Native gardeners are not always so conscientious over work of this nature as is desirable, unless they know that their shortcomings will be detected easily.

A whale oil soap spray might well be tried against the larval stages of this insect.

In the case of trees which have been cut back, attention should be given to tarring or otherwise protecting the exposed surfaces. Failing such precautions, it is most probable that the trees will be invaded by the lebbek beetle or "borer" (*Xystrocera globosa*, Oliv.). The females of this species appear to be particularly attracted to wounds or cut surfaces, in which they lay their eggs.

Since at the time of the mealy bug attack in Cairo, there were no suitable spray pumps available for the application of insecticides to such tall trees as the lebbek, the use of the city fire engines was suggested. There can be little doubt that a great deal of benefit would have resulted if infested trees could have been thoroughly washed with a really powerful stream of plain water, such as is delivered by a steam fire engine. Not only numbers of larvæ, but also females and their ovisacs, could have been washed off and destroyed by a stream of water delivered at high pressure. It is probable that the crowns of many trees might have been saved in this manner. Unfortunately, however, it was considered by the authorities—who were, no doubt, quite correct in their conclusions—to be impracticable; since it was thought highly probable that considerable damage might result to glass windows and other property, if this method of dealing with the mealy bug were given a trial; and owing to the Capitulations, numerous actions would



F. C. WILLCOCKS, Photo.

PART OF CAIRO, SHOWING STREETS INFESTED BY MEALY BUG MARKED IN BLACK.

then have been brought by people of various nationalities against the Government for real or fancied damages.

The same objections apply, of course, to the use and application in the ordinary manner of any insecticides to trees in the main thoroughfares of the city. Many persons would be certain to insist that injury had been done to their houses, goods or persons by the drip from trees sprayed with paraffin emulsion or other materials. Traffic would have to be stopped temporarily in those streets where spraying operations were in force, and windows, etc., would have to be kept closed. It is said that this alone would be very difficult to carry out, and the two sets of objections form an insurmountable difficulty so far as spraying is concerned.

It is difficult, therefore, to see along what lines the control of the mealy bug can be attained. The only course open appears to be to endeavour to improve the health of the trees, trusting that their increased vigour, in conjunction with natural enemies, will prevent the mealy bug from increasing to injurious proportions. The only other direction in which something can be done is to replace the lebbek by a tree whose insect pests are not so difficult to control. This is being done in Cairo in those streets which were so severely injured by the mealy bug during the past year. Attempts might also be made to propagate some of the more important insect enemies of the *Dactylopius* on a large scale in an insectarium, so that their numbers might be considerably increased in the more heavily infected areas.

APPENDIX I.

CHARACTERS AND GENERAL MORPHOLOGY OF THE LEBBEK SCALE

By R. Newstead, M.Sc., A.L.S., and F. C. Willcocks.

Dactylopius * **perniciosus**, sp. n. (Newstead & Willcocks).

Ovisac of female (see fig. 2, p. 124). White, or rarely pale buff. Usually more or less reniform, rarely quite globular or more or less hemispherical; surface with well-marked transverse flutings and sometimes also with faint longitudinal striæ. The waxen plates and mealy secretion of the female are

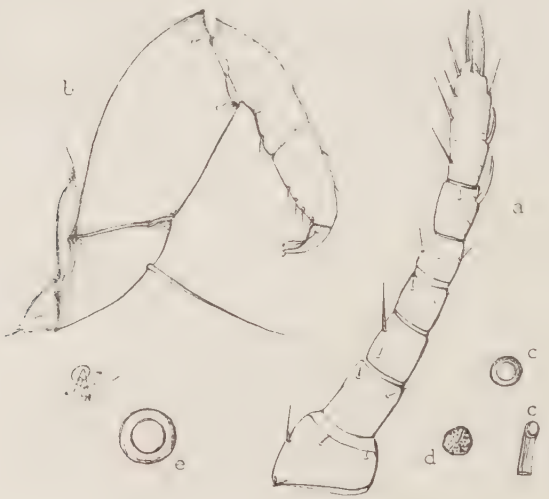


Fig. 10.—*Dactylopius perniciosus*, female; *a*, antenna; *b*, leg; *c, d, e*, spinnerets.

often visible on the exterior, more especially so in the earlier stages of the formation of the ovisac. When quite intact it has a closely felted appearance, but on the least disturbance the material is capable of stretching out

* Fernald, Catalogue Coccidæ of the World, p. 96, gives *Pseudococcus*, Westwood (1841) priority. To adopt such a change in the nomenclature would lead to endless confusion in the literature of Economic Entomology; and for this reason the name which has been so long in use has been retained.

into long, viscous, elastic threads interwoven with a granular or mealy secretion, which latter disperses in the form of a little cloud of white smoke.

Length 3–5 mm.; rarely attaining a length of 7 mm.

Female adult. Dorsum covered with a thick layer of white, rarely pale buff, secretion, which when examined under a microscope is seen to consist of minute granular, and short curved hair-like, bodies. Colour, when completely denuded of the white secretion, black; integument smooth and shining. Body fluids deep brownish purple. Form of the early adult, ovate, tumid; segmentation distinct. Older examples at the period of parturition become much narrowed anteriorly, presenting a more or less pyriform or cordate outline. Antennæ short (fig. 10 *a*), of seven segments; but the seventh segment has often a pseudo-articulation in the middle, though in many individuals there is no visible indication of this; there is a large curved spine at the distal extremity of the sixth, and a similar spine in the middle of the seventh or immediately below the pseudo-articulation, when the latter is present; apex of last segment with several long spinose hairs, of which at least one is much stouter than the rest; hairs on remaining segments short and slender. Legs (fig. 10 *b*) very short and stout, being but a very little longer than the antennæ. Derm rather thickly studded with spinnerets, especially towards the anal extremity; these are of three types: a small circular form with long subcutaneous tubes (fig. 10 *c*); an irregular form (fig. 10 *d*); and a large circular form (fig. 10 *e*), also without subcutaneous tubes. Anal lobes and anal orifice normal. Mentum large, biarticulate, apex with many spinose hairs. Abdominal and thoracic "cicatrices" absent. Stigmata large, equal in length to the trochanters.

Length 2·50–4·75 mm.; width 2–3·75 mm.

Orisac of male. This is formed of loose flocculent material.

Male. Slightly mealy or farinose. General colour dark brown with a tinge of red or purple. Head dull ochreous tinged with dusky brown. Eyes and ocelli ruby-red with a dark centre. Legs ochreous, with darker shadings. Wings and caudal filaments white. Some examples are of a generally darker colour than others, a character possibly due to age. Antennæ sparsely spinose, the spines being long and slender; there are also a few comparatively short hairs, but these are scattered and occur at much wider intervals than the spines. Legs spinose, the spines slender; but there are two at the distal extremity of the tibiæ which are longer and stouter than the rest. Ocelli two in number; these are placed on the lateral margin of the head.

Wing expanse 2·4 mm. Length of body 1·3 mm.

Pupa. Slightly farinose. Brown tinged with purplish red; wing-cases, antennæ and legs translucent, and almost glassy in appearance. Some examples have a white caudal mass of secretionary matter, equal to one half of the length of the body. It is active or at least capable of locomotion;

this, however, is a character common to the pupæ of certain other members of the genus.

Average length 1 mm.

Larva. Farinose. Rich brown tinged with purplish: head, antennæ, legs and apex of abdomen inclined to ochreous, shaded with brown.

Ovum. Generally rich brown tinged with purplish, but some are decidedly paler than others, being inclined to ochreous brown. Cuticle smooth and slightly polished. Generally sparsely mealy and often with a few threads of the secretionary matter of the ovisac attached thereto.

Length 0·38–0·40 mm.; diameter 0·22–0·24 mm.

Cockerell's *Dactylopius hymenoclea* * is very closely related to *D. perniciosus*. In both insects the pigment changes to a dark green colour when boiled in caustic potash. The ovisacs are also almost identical. In *D. perniciosus*, however, there is a total absence of the "dagger-shaped spines in the caudal region" (Cockerell, *l. c.*), and also the "minute denticle" on the ventral surface of the claw. This species may be further distinguished from *D. hymenoclea* by the presence of well-marked spines on the antennæ.

June 6th, 1910.

* Canadian Entomologist, xxxi, p. 267 (1891).

APPENDIX II.

THE CHEMICAL ANALYSIS OF THE SECRETIONARY COVERING OF *DACTYLOPIUS PERNICIOSUS*.

By Frank Hughes, *Chemist to the Khedivial Agricultural Society.*

The scale [scale here means both the insects and their ovisacs—F. C. W.] contains a small amount of *wax* which can be separated by solution in boiling alcohol, or better, petrol. From solution in the latter it yields, after recrystallization, a considerable proportion of a hard wax melting at 83°·5 and having a density of 0·970 at 15° C. This is in all probability *Ceryl cerotate*. There is present a mixture of waxes of lower and indefinite melting-point.

The *fibrous material* of the scale [=ovisac] is insoluble in water or alcohol, but easily soluble in dilute alkali, from which solution it is precipitated by acids. Its properties agree very closely with those of *fibroin*.

Cane sugar is present in considerable amount in the "honey dew," as well as a trace of reducing sugar.

A *colouring matter* of a reddish crimson is present. This can be extracted with water, or better, alcohol. In the latter solvent the absorption spectrum resembles, though it is not identical with, that of cochineal. Acids have little effect on the colour nor has ammonia; it is, however, changed to a brownish green by the addition of a large excess of alkali.

NOTES ON THE HABITS OF *GLOSSINA FUSCA*.

By J. B. DAVEY, M.B. (Lond.), D.T.M. (Liverpool),
Medical Officer, Nyasaland Administration.

Much attention has recently been devoted to the habits of *Glossina palpalis*, but *G. fusca*, which I have had the opportunity of observing and collecting in several localities in Nyasaland, has received little notice; the latter has long been known to be most active in the evening, but further points in its habits have come to my notice, and they appear to be worth recording.

Localities in Nyasaland where G. fusca *occurs.*

There are two places in Nyasaland where, for some years, *G. fusca* has been known to occur, viz. (1) near Masinjiri's village, in the Elephant Marsh, near the Lower Shire River: they were, I believe, first found here by Major Pearce, Acting Governor of Nyasaland; (2) at Kaporo, near the north end of Lake Nyasa, where Dr. J. E. S. Old discovered them. Some years ago Mr. Crawshay reported them from near the South Rukuru River, but attempts to find them there recently have not been successful. One or two specimens are also said to have been captured near Monkey Bay. Recently, in travelling down Lake Nyasa by boat, I encountered *G. fusca* at five places in the Marimba and Central Angoniland districts near the lake shore.

Numerical Distribution.

At Masinjiri's and Kaporo I have found the flies numerous on all of several visits, and there was little difficulty in collecting a score or more in an evening. In the Marimba and Central Angoniland districts, five (three males, two females) was the maximum number found at any one place, although several hours were spent in searching for them in some instances.

G. fusca would appear then to occur under two conditions: firstly, in considerable numbers over a limited area—they do not seem to extend over wide tracts of country as does *G. morsitans*; they may be found evening after evening occupying almost precisely the same stretch of road or path, as at Masinjiri's and Kaporo, where they occur along about a thousand yards of path. Secondly, in very small numbers, as in the localities near the Marimba and Central Angoniland shores of the lake. It should, however, be observed that Masinjiri's and Kaporo were visited in the dry, the other places in the wet, season.

Nature of the Country.

In all the places, excepting one referred to below, there is abundant shade and, in most, there is a considerable growth of creepers in addition to the usual young forest trees ; it was observed that the *G. fusca* were most numerous under the largest trees. There is water close at hand in all cases ; in the lake districts *G. fusca* was usually found within six hundred yards of the lake and, at more than one place where *G. morsitans* was also found, one noticed that the latter occupied the country further from the lake than *G. fusca* ; on one occasion, however, both were caught within a few yards of one another.

At one place in Marimba district a single specimen of *G. fusca* was caught about 7 A.M., a few yards from the lake, amongst some " bango " reeds, and, at this place, there were but three or four stunted trees within a mile of the lake, the country being open grassy plain.

On another occasion a single specimen was caught settling on the finger of a native standing under a tree in the middle of a small village, the huts composing which were somewhat scattered amongst palms and other trees.

All the localities in which *G. fusca* was found are relatively low-lying, Masinjiri's being about 300 and the lake about 1300 feet above sea-level.

Time of Activity.

G. fusca is extremely difficult to find, except in the evening and very early morning. About 4 P.M. it seems to emerge from its hiding place and settle on dried leaves, sticks or dust on paths, apparently lying in wait for a meal. I have noticed that game, on its way to water in the evening, often stands for a time on emerging from the forest on to a path, and would thus afford the fly an opportunity for feeding. As a rule, *G. fusca* seems ready to bite human beings in the evening, but it does not set to work with the rapidity and voracity that *G. morsitans* often exhibits. I have noticed, as did also the natives with me, that both *G. morsitans* and *G. fusca* often preferred to settle on my kakhi shirt rather than on the bare legs or back of the native, but the former, when in a voracious mood, would settle direct on some bare part of myself or a native and begin to bite almost immediately.

In the very early morning *G. fusca* has been observed flying about and apparently taking its departure to its day haunts.

At Kaporo, where *G. fusca* is fairly numerous, I succeeded, after some trouble, in finding it in the middle of the day. It then was resting on tree-trunks, 2 or 3 feet from the ground, and was difficult to detect and capture, as it selected trees surrounded by creepers and undergrowth, and hid away in crevices in the bark or under the origin of branches. It appeared to rest motionless until disturbed, when it quickly flew round to the other side of the tree or to an adjoining tree, never going far, and making no attempt to

settle on and bite one. There were none to be found at their usual evening haunt on the path, which was only a few yards distant. *G. fusca* rests with the head directed upwards or downwards and raised off the tree-trunk by the legs: the abdomen, at its hinder part, almost touches the tree: sometimes it moves sideways on its legs round a tree-trunk on seeing an intruder approach. One pair was observed *in coitû* on a tree at midday, the terminal abdominal segment of the male, which was on the back of the female, being curved round the terminal segment of the latter; at intervals the male made a rapid vibratory movement of the wings: the wings of the female were slightly abducted from the body. They were so firmly locked that one was able to capture and kill them without causing separation. Attempts to find larvæ and pupæ by digging round the bases of various trees were unsuccessful.

Relation to Game.

At all places where *G. fusca* was found, game (antelope, warthog, etc.) was abundant. On one occasion, after searching for tsetse for some time without success, I came upon and shot two bush-pigs about sunset, and on going up to them found several *G. fusca* alighting upon and apparently trying to suck blood from the pigs. This was in the wet season. One female extruded an immature larva on capture.

Relation of the Sexes.

Of 117 *G. fusca* captured at Kaporo in the evenings in August (dry season), all were males. Seven were captured at the same place and time of year about midday, and of these four were males and three were females.

Trypanosomes in the Abdominal Contents.

Twenty-two males were examined: in two, very numerous trypanosomes, resembling *T. gragi*, were found; in the others examination gave a negative result.

[To the above valuable and interesting account of the habits of *G. fusca*, it may be well to add the following notes recently received from Dr. E. H. Allon Pask, Medical Officer, Dowa, Nyasaland:—"*G. fusca*. Lake shore, between Mkula River and Chima River; collected 18.iii.10, on native path and in village, 7–9 A.M., sandy soil, scant vegetation, and also in track through high grass, scantily wooded. Edge of Lake Nyasa about 400 yards away, in other places further still: separated from water by high reeds. Wet season. Found in association with *G. morsitans*. Fly not numerous, about a dozen *G. fusca* caught and two *G. morsitans*." And again: "*G. fusca*. Lake shore, mouth of Lingadni River, collected 19.iii.10, in a village; one

caught at 4 P.M. and one after sunset (biting a native). Fairly thick forest surrounding village: about half a mile from water's edge. Wet season. No other species of *Glossina* caught, but *G. morsitans* plentiful a mile away. Goats are kept in the village. Only two specimens obtained here."

In a letter received from Mr. S. A. Neave as this goes to press, he states that he has taken one specimen of *G. fusca* on the Muwona stream, some ten miles north of Chiromo. He considers it highly probable that this species occurs throughout a wide area in Nyasaland, but that owing to the small numbers in which it occurs in any one spot, it is frequently overlooked unless a prolonged search is made.

The only place south of the Zambesi in which *G. fusca* is at present known to occur is Bamboo Creek, on the Beira Railway, where it was taken by Mr. Ll. E. W. Bevan.

In view of the possibility that this species may prove to be a carrier of sleeping sickness any details as to its occurrence or habits are of importance, especially as regards Nyasaland and Rhodesia.—Ed.]

CONCERNING *GLOSSINA MORSITANS*.

The recent outbreaks of trypanosomiasis among cattle in certain districts of Southern Rhodesia have again emphasised the urgent need for a fuller scientific investigation into the causation of this disease, and the possible means of prevention. Little practical progress has been made since Bruce's admirable reports on the subject, but the valuable work which he initiated in Zululand requires to be confirmed and extended in Tropical Africa. For at the time of his enquiry it was supposed that the trypanosomiases of domestic animals were due to a single species of trypanosome, which was conveyed by a single species of *Glossina*. Now, however, it is known that, both as regards the protozoon and the transmitting insect, two or more species may be involved; so that the problem assumes a considerably greater complexity. In these circumstances any hasty conclusions as to the best methods of extirpating the disease, or diseases, are to be deprecated, pending an authoritative investigation into several aspects of the question, concerning which we are at present deplorably ignorant.

The Entomological Research Committee has recently appointed a Subcommittee, under the chairmanship of Sir John McFadyean, Principal of the Royal Veterinary College, London, whose object it will be to accumulate evidence and to stimulate observations with reference to this subject. The other members of the Subcommittee are:—Mr. E. E. Austen, of the British Museum (Natural History); Dr. A. G. Bagshawe, Director of the Sleeping Sickness Bureau; Prof. G. H. F. Nuttall, F.R.S., Quick Professor of Zoology, Cambridge; Mr. Stewart Stockman, Chief Veterinary Officer to the Board of Agriculture; and Mr. Guy A. K. Marshall (Scientific Secretary).

The Subcommittee have drafted the following brief survey of some of the more important points, concerning which further observations and experiments are much needed. They will always be pleased to receive from field observers any information bearing upon these subjects. Communications should be sent to the Scientific Secretary, Entomological Research Committee, British Museum (Natural History), Cromwell Road, London, S.W.

I. The General Habits, etc., of *Glossina morsitans*.

Fly-areas.—Exact descriptions are needed of areas where the flies are found, with notes as to altitude, proportion of trees or woody scrub to grass, soil, rain-fall, etc. Similar areas where no flies are found should be studied to find out wherein the fly-area and the non-fly areas differ. The soil and the vegetation should be compared, and the co-operation of a botantist is

advisable, if not essential. Any preconceived notion as to the association of fly with big game should be set aside. This study should be continued over a year *at least*, so as to include wet and dry seasons and intermediate periods. The area should be accurately plotted on a large-scale map and the result checked at regular intervals to determine the seasonal variations. No such study has been made of a *morsitans* area. The distribution of wild animals (not only "big game") which might serve as food should be similarly plotted.

Breeding-grounds.—It is probable that the localisation, both general and special, of *morsitans* depends on the requirements of the pupa, and that, when the breeding-grounds are found and studied, much that is puzzling in its topical distribution will be explained. The natural breeding-grounds have never been discovered. Their site will be determined chiefly by conditions of shade and soil. They will occur in places sheltered from grass fires. When the breeding-grounds have been discovered, it may be possible to rid large areas from fly by the removal of certain shrubs. The relation of breeding to season must be carefully studied. It has been pointed out that tsetse are often found in sandy places. Sand is the ideal soil for the protection of the pupæ.

Diet.—Observations whether *morsitans* drinks water or feeds on anything but blood are needed.

Seasonal variations.—On what do the seasonal variations in numbers depend, and what is their exact relation to meteorological conditions? Is the diminution of numbers during the dry season due to scarcity of animals on which to feed, or to the attacks of birds or other enemies, or to abeyance of breeding, or to delayed pupation so that few flies hatch out? In prolonged drought it is possible that all the adult flies die off, and that the continued existence of the species is insured by the hatching out of old pupæ at the beginning of the rains. If larvæ or pupæ can be obtained, the effect on development of varying degrees of dryness and moisture should be experimentally tested.

Enemies.—What enemies has the fly, either in the pupal or mature stage?

Presence on one bank only of a river.—Tsetse sometimes are found on one bank of a river but not on the other. What is the reason? Is there in such cases a difference of soil, which favours perhaps the deposit of larvæ on one side but not on the other?

Sex proportion.—On what does the usual predominance of males depend? Does it, as with *palpalis*, vary with locality? Does it depend on the position of the breeding-grounds? Is it a real excess, or only that males allow themselves to be caught more readily than females?

Animals specially attacked.—It has been frequently noticed that tsetse flies will often settle in some numbers on an animal that has just been shot.

Where flies are plentiful their preferences, if any, might be ascertained by observing to what extent they are attracted by the carcases of different animals. The smaller animals should be specially observed, *e. g.*, guinea-fowl, hares, jackals, baboons, duiker and pig.

Attractive and repellent substances.—There is ample scope for experiment in the hope of discovering some substance which is specially attractive to these flies ; if such could be found, it would be of inestimable value, as it would enable us to trap and destroy large numbers of the insects. Maldonado's trap (*vide* Bull. Ent. Res. part 1, p. 85) should be systematically tested. An efficient dressing may yet be discovered which will deter tsetses from biting stock for a serviceable period ; no really exhaustive experiments have yet been made for this purpose.

Miscellaneous.—Montgomery says that tsetse-flies will plague a moving man or animal, but if he stops they will leave him. Is this generally so? If it is, what is the reason?

When notes on the bionomics of the fly are sent in, exact information should be given as to the climatic and other conditions : if the rains have been falling, if so, how long ; if not, when they will begin ; whether the grass has been burnt ; and so forth.

Observers who are noting the habits, life-history, etc. of tsetse-flies must be quite certain of the species with which they are dealing, *e. g.*, whether it is *morsitans* or *pallidipes* or a mixture of more than one species. Neglect of this precaution may account for many discrepancies in the observations of modern as well as ancient authors. It is not improbable, for instance, that the habits of *morsitans* and *pallidipes* differ in some important particulars.

II. The Investigation of Pathogenic Trypanosomes in Wild Animals.

Necessity for animal inoculation.—In the investigation of this problem it is not enough to examine blood-smears from all the animals in any locality. The parasites may be so rare that prolonged search through many slides will fail to discover a single one. The much more delicate method of *animal inoculation* must be used. The experiments of Bruce in Zululand demonstrated this. With precautions against their becoming infected in natural ways he injected the blood of forty-five wild animals into healthy dogs. Of these eleven became infected. In three cases only was he able to find trypanosomes in the blood of wild animals by direct examination. He writes:—"The parasites were few and far between, and it was only by long and patient searching that they could be found at all." The investigations of others (Dutton and Todd ; Montgomery and Kinghorn ; Brand) go also to show that animal inoculation *must* be practised. By this or the direct method, in Zululand the blood of buffalo, hyæna, and five species of antelope was shown

to be infective; in North-Eastern Rhodesia of two species of antelope; in the Congo State of one.

Conditions for inoculation experiments.—Such experiments must be carried out by a competent person and all precautions taken against infection through natural channels. Montgomery and Kinghorn write:—"The ideal system would be to establish temporary camps in various districts with a plentiful stock of healthy animals carefully protected in fly-proof cages at hand, and to inoculate such immediately on the death of the game, or to convey citrated blood back with as little delay as possible. This would have to be carried out in both clean (fly-free) and tsetse-infested districts; and it is one of the first problems in the etiology of trypanosomiasis that this should be undertaken. In Northern Rhodesia, and elsewhere, considerable difficulties will be experienced owing to the non-pathogenicity of certain endemic trypanosomes towards the ordinary laboratory animals; it would appear almost imperative, therefore, that sheep and goats should be employed."

Choice of experimental animal.—The latter part of this quotation illustrates one of the difficulties, that of finding a suitable susceptible animal. For the Zululand trypanosome the dog was such an animal, as appears to have been the case also in inoculation experiments by Brand in Northern Nigeria. In North-Eastern Rhodesia on the other hand, inoculated dogs often failed to show trypanosomes, even though they became ill and died. It was necessary to use sheep and goats.

Bouffard, who reported on a trypanosome disease in the Niger territory known as Baleri (*Trypanosoma pecaudi*), found the cat the most useful animal for inoculation purposes. It sickened surely and rapidly, and was easily handled.

The choice of the experimental animal is most important. It should be a species which not only invariably becomes infected but shows also a good blood invasion of parasites, so that the diagnosis can be readily made. For reasons of expense both in purchase and maintenance, it should be of small size. Sheep and goats do not conform well to these conditions. There are, however, animal trypanosomiases, *e.g.* those due to *Trypanosoma vivax*, *Trypanosoma cazalboui*, and to some extent to *Trypanosoma nanum*, which cannot be transmitted to the small laboratory animals.

Owing to "individual equation" in any susceptible species, it is well to inoculate more than one animal in any given case. The inoculation should be done in a uniform way, either beneath the skin or peritoneum, and a similar dose employed. The dose should be diluted with saline solution, for, when this precaution is omitted, infection sometimes fails. When possible, blood from a suspect should be taken at intervals for testing, as it might be non-virulent one day and virulent another.

Inoculations to be made from the smaller mammals.—All inoculations recorded up to now have been made from the larger animals. It is important that the

smaller mammals, *e. g.* monkeys, rodents, etc., should be included in the enquiry, for if they also act as reservoirs the destruction or removal of big game would not materially lessen the danger to domestic animals.

Cultures to be made from blood.—An attempt should be made to cultivate trypanosomes from the blood of wild animals on artificial media. In this way the presence of parasites which are very scarce in the blood can be demonstrated, and one may get information, or at least a hint, as to the species to which they belong.

The probability that domestic animals belonging to a breed which has long been subject to the attacks of tsetse may have become relatively immune to the trypanosomes inoculated by the fly, though harbouring the parasites in their blood, must always be remembered and a careful watch kept for such cases. Animals of this kind might obviously serve as foci for infection of non-immune stock.

For the purpose of collecting evidence with regard to the habits of *Glossina morsitans*, the Colonial Office have kindly made arrangements for the printing and distribution of the following interrogatory. It is earnestly to be hoped that those into whose hands these questions may fall will endeavour to further this important enquiry to the best of their ability.

AN INVESTIGATION INTO THE HABITS AND DISTRIBUTION OF THE CATTLE TSETSE FLIES (*GLOSSINA*).

Since the middle of the last century numerous travellers have given more or less detailed, though often conflicting, accounts of *Glossina morsitans* and its habits, but hitherto it has not been studied on any system, nor have we the accounts of men who have been long resident in one spot. Though it is generally accepted that this fly is one of the greatest enemies to farmers and stock-raisers in South Africa, we have at present no practicable method of dealing with it. Our helplessness in this regard is due to ignorance, ignorance which it is the task of all persons interested to dispel. It is hoped by the dissemination of a series of specific questions to obtain specific answers in such number that a foundation of accurate knowledge may be laid, and that eventually it may be possible to devise cheap and effective means of exterminating the fly in important areas. Those who answer these questions should observe the following precautions :—

The answers should be concise and to the point, and should be distinguished by numbers corresponding with those of the questions to which they refer.

Names and places which can be verified, and dates, should be given.

Any information beyond the scope of the questions should be added in an Appendix.

If the reporter is in doubt as to the species of tsetse, or whether more than one is present, specimens should be sent with the replies.

He should in no case rely on native evidence.

The longer the reporter has been resident in or near the fly-area the more weight will his evidence carry.

The answers should be written on one side of the paper only.

1. Are you resident in, or near, a fly-area? In the latter case how far are you distant from the nearest point of the area?

2. How long have you been resident in the vicinity?

3. Can you state approximately the size of the fly-area? (Give a sketch-map, if possible.)

4. Has this area appreciably increased or diminished in your own experience?

5. If so, can you state the date at which these alterations took place, and the nature of the climatic conditions at the time?

6. Was there any appreciable increase or diminution of wild animals about that time?

7. Does the fly-area contain *Glossina morsitans* only or have you reason to believe that another species of tsetse is present as well?

8. Does the size of the fly-area vary at different times of the year, and if so, is there a definite relation between these variations and the dry and rainy seasons respectively or the prevalence of wind?

9. Are the limits of the fly-belt sharply defined, and if so, what is the nature of the limiting boundaries?

10. Are there any natural features which are specially characteristic of the fly-belt and which are not to be found in the surrounding fly-free areas (*e.g.* nature of soil, bush, herbage, presence or absence of water)?

11. Are there any such features which you have specially noticed to be present in every fly-belt you have visited? *E.g.*, Does the presence of fly in large numbers seem to be associated with that of sand?

12. Have you ever observed a tsetse-fly depositing its larva, and if so, can you describe the circumstances?

13. Have you observed any marked differences in the number of tsetses in a particular area at different seasons? If so, describe these differences.

14. To what do you attribute such differences?

15. Have you made any attempts to trap tsetses with pieces of black cloth or paper worn by men or animals and smeared with bird-lime, and if so, with what success? Have you tried any method of deterring the flies from biting animals while passing through a fly-belt?

16. Do you know of any mammals, birds, reptiles, or predaceous or parasitic insects which actually destroy tsetse-flies?

17. Are there, within your knowledge, any facts which lead you to believe that tsetse-flies are entirely dependent for their continued existence upon the blood of wild mammals?

18. Have you any reason to believe that tsetses are specially dependent upon and associated with any particular species of mammals?

19. Have you ever observed tsetses feeding upon birds, lizards or crocodiles?

20. Have you any reason to suppose that tsetses may be capable of subsisting on the juices of plants or that they suck up water or dew?

21. Do you personally know any facts tending to show that tsetses move about with big game either in the natural migrations of the latter or when they are driven away, and return when or soon after the game returns?

22. Are you acquainted with any instance in which the appearance of tsetses in a new locality has been due to the movement of natives?

23. Do you know personally of any cases of healthy domesticated animals of any kind living at a Kafir kraal within a fly-belt?

CURRENT NOTES.

In the 'Annals of Tropical Medicine and Parasitology,' vol. iii, no. 5, Mr. F. C. Willcocks gives some interesting preliminary notes on the prevalence and habits of mosquitoes in Cairo and its environs. He comments on the comparative rarity of malaria in Egypt, in spite of the extreme abundance of the Anopheline, *Cellia pharoensis*, Theob., and tentatively suggests that perhaps this mosquito is not really a carrier of malaria; a view for which there appears to be some justification. The only other Anopheline mentioned as occurring in the area dealt with is a new species of *Pyretophorus*, and it is possible that this much scarcer species may eventually prove to be responsible for such malaria as exists. The larvæ of this *Pyretophorus* were found in brackish waters, and flourished in large numbers in the presence of 2·56 to 3·25 per cent. of common salt; though even 1 per cent. of salt proved eventually fatal to the larvæ of *Cellia*. In this connection it may be interesting to recall that in Southern Nigeria Dr. W. M. Graham has observed that the larvæ of *Pyretophorus costalis*, Loew, can be destroyed by an addition of 3 per cent. of common salt to the water in which they live, the salt causing the disintegration and precipitation of the motile algæ upon which the larvæ feed (Bull. Ent. Res. part i, p. 51).

In the same publication as the foregoing, Sir Rubert Boyce, F.R.S., and Mr. F. C. Lewis give a short account of some useful experiments which were made for the purpose of testing the validity of the contention that the presence of mosquito larvæ in drinking water was beneficial; this idea being based upon the assumption that these larvæ feed largely on bacteria, and would therefore tend to eliminate pathogenic forms. The results obtained by the authors by no means support these conclusions, for as they say:—"From these experiments, it will be seen that in clean drinking water, drawn from the tap and exposed to the air, there is a slight multiplication of the number of bacteria for a few days, and that then the bacteria rapidly decrease, in all probability owing to the want of food material. If, however, living larvæ are placed in the water, there is a very rapid rise in the number of bacteria per c.c., which is enormously increased if a larva happens to die. In other words, larvæ add something to the water, probably mucus, which acts as food material, and which therefore increases the rate of development of the bacteria, and a dead larva in decomposing still further increases the bacterial proportion. In the case where typhoid bacilli were added to the water, the presence of the larvæ did not appear to have the least effect in reducing their numbers; on the contrary, the total number of all bacteria went up. . . . . The evidence, therefore, strongly points to the fact that larvæ in water will

still further pollute it. The observations upon *Cyclops*, as far as they go, also point in the same direction." The screening of water-tubs, tanks, etc., in the vicinity of houses, so as to prevent mosquitoes from laying eggs therein, may therefore be regarded as an unmixed benefit, and should be rigidly enforced by the proper authorities in all malarial centres.

In the June number of 'Science' (1910, i, p. 869), Dr. Frederick Knab rightly emphasises the importance of ascertaining precisely the habits of any given species of mosquito before money is expended on its destruction. On the littoral of Tropical America two species, *Culex extricator* and *Deinocerites* sp., breed abundantly and exclusively in crab-holes. It has been suggested that measures should be taken to exterminate their larvæ, and to this Dr. Knab takes exception, on the ground that there is no evidence that either species ever enters human habitations, and further that no signs of blood could be found in the females of the *Culex* which had been examined. Whatever may prove to be the truth in this particular instance, it is well to remember that although the number of mosquitoes now known to inhabit Africa is very considerable, yet there are very few of which we can say, with any degree of certainty, that they feed on the blood of man or domesticated animals. More precise records with regard to this important point are much to be desired.

In the same article Dr. Knab contests the supposition that the yellow-fever mosquito (*Stegomyia fasciata*, F.) lays its eggs actually on the surface of the water. He states that "the eggs are deposited out of the water, at the edge of the water film: here the eggs remain until they are submerged, when they promptly hatch. Eggs remaining out of the water retain their vitality for a long time. In laboratory experiments eggs have been kept dry as long as five months and, when then submerged, produced larvæ; under favourable conditions out-of-doors it is to be supposed that they will survive even longer." These interesting observations may account to some extent for the wide dispersal of this dangerous pest; for the prolonged vitality of the eggs and the situations in which they are laid render it probable that they might occasionally be carried for considerable distances adhering to the feet of water-birds.

Some two years ago an attempt was made to introduce into Algeria, from Louisiana, a colony of the fossorial wasp, *Monedula carolina*. These wasps feed principally upon TABANIDÆ (variously known as horse-flies, hippo-flies, seroots, etc.), and it was hoped that they might prove effective in reducing the numbers of those species of *Tabanus* which are probably responsible for the dissemination of the trypanosomiasis of camels. The insects were exported in the pupal stage, the pupæ being kept in cold storage to check their emergence. A number of them survived the ordeal and were placed out in

suitable localities on arrival, but so far there is no evidence to show that they have actually succeeded in establishing themselves. We learn, however, from Mr. Van Dine, of the Audubon Park Laboratory, New Orleans, that a further consignment of these insects is shortly to be sent over to Algeria, and the result of the experiment will be awaited with interest; for anything that will effectively diminish the numbers of the abundant African TABANIDÆ will be of practical utility. If the American wasps fail to establish themselves, it may be recalled that there are two allied species with similar habits in Southern Europe; for the food of *Bembex rostrata*, F., and *B. bidentata*, V. L., is stated by Fabre to consist almost entirely of species of *Tabanus*. Moreover, we at present know practically nothing as to the food-habits of the various species of *Bembex* and *Stizus* which occur in Tropical Africa. Doubtless some of these will be found to prey on TABANIDÆ, and if so, it would be important for local observers to ascertain how far their presence operates as a check upon these blood-thirsty flies.

It may be well to draw attention to the fact that among some parasitic worms recently brought home from Nyasaland by Dr. J. B. Davey, there was one species which had been taken from the stomachs of various calves, which had died from some undetermined cause. These worms have been kindly identified by Dr. Robert T. Leiper as being *Hæmonchus contortus*, and he adds that "these parasites are a very common source of verminous gastritis, pernicious anæmia and death in young calves. They are exceedingly difficult to eradicate, and the United States Bureau of Animal Industry has devoted a considerable amount of attention to the subject of recent years."

The recent discovery of still further cases of sleeping sickness in the lower Luangwa Valley, in North-Eastern Rhodesia, at a distance of more than 200 miles from the nearest *Glossina palpalis* area, indicates the necessity for a prompt and thorough investigation into all the possible sources of infection in that vicinity. The question of these sporadic cases of sleeping sickness in Nyasaland and the southern parts of Northern Rhodesia is dealt with by Dr. A. G. Bagshawe in the current number of the 'Sleeping Sickness Bulletin' (no. 18), and he there states that "in these countries during the past twelve months trypanosomiasis has been detected in twenty-eight persons, some of whom had certainly never visited a *palpalis* area. Of the twenty-eight, six were Europeans whose movements could be traced with exactness." For more than one reason, it is very improbable that *G. palpalis* is actually present in the suspected areas and has escaped observation, and we must therefore be prepared to contemplate the probability that some other species is capable of transmitting the disease. Dr. Bagshawe tentatively suggests the possibility that the power of transmission is not confined to some particular species, but that climate and altitude may be the real controlling factors. In

other words, *G. morsitans*, etc., may be incapable of transmitting *Trypanosoma gambiense* on open, higher ground, but might become carriers in the more favourable conditions obtaining in a hot damp valley. A somewhat parallel phenomenon is known to occur in the case of certain disease-carrying ticks and mosquitoes, and this hypothesis should certainly be made the subject of careful experiment in suitable localities. At the same time, it would appear that the facts, so far as we at present know them, are not inconsistent with the supposition that most of these cases may be due to normal transmission by *Glossina fusca*, simply owing to the presence of a reservoir and without reference to any special environment. In this latter case, the disease might appear over a comparatively wide area, but its incidence would probably be light, owing to the relative scarcity of the fly. If, however, Dr. Bagshawe's hypothesis be sound, the probability of a severe epidemic in the Luangwa and Zambesi valleys would have to be reckoned with.

Mr. S. A. Neave, the Committee's Entomologist in East Africa, has recently visited the shores of the southern end of Lake Nyasa. He could find no signs of *Glossina palpalis*, and he considers that the nature of the vegetation and the general character of the insect fauna render it highly improbable that the species will be found there. *G. morsitans* was found abundantly on the upper Shire River and on the western shores of Lake Nyasa, though in the latter case it was more plentiful half a mile or so inland than on the actual shore ; this species appeared to be absent from the eastern side of the Lake. Mr. Neave has also traversed the southern portion of the Protectorate, and is now proceeding by land along the whole western side of the Lake, leaving Karonga about the middle of July and striking across German East Africa to Mombasa.

On the West Coast, Mr. J. J. Simpson has already visited all the medical posts in the Western Province of Southern Nigeria and most of those in the Central Province. He is now traversing the Eastern Province, and will then proceed to Northern Nigeria. Encouraging reports have been received from both Entomologists with regard to the cooperation of medical and other officers in furthering the work of the Committee.

Arrangements have been made by the Colonial Office for short courses in Entomology to be given at the two Schools of Tropical Medicine, at Oxford, Cambridge, Edinburgh and Dublin, for the benefit of Officers in the African Colonies and Protectorates when home on leave. Advantage has already been taken of this in a number of cases, for during the present summer the following numbers have taken, or are taking, courses in Entomology :— Gold Coast 7, Sierra Leone 2, N. Nigeria 1, S. Nigeria 8, East Africa Protectorate 3, Uganda 1, Nyasaland 2 ; making a total of 24. In addition, 22 other names have been sent in of Officers who desire to take the course in the near future.

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen who have kindly presented Collections of insects :—

Dr. A. H. Barclay :—321 Tabanidæ, 37 *Glossina*, 3 *Stomoxys* and 9 other Diptera, from Fort Johnston and Fort Maguire, Nyasaland.

Dr. A. Connal :—5 Tabanidæ, 2 Nycteribiidæ and 2 Hippoboscidæ, from Yaba, near Lagos.

Dr. J. B. Davey :—157 *Glossina*, 200 Tabanidæ, 24 *Stomoxys*, 12 Culicidæ, 44 Hippoboscidæ, 403 other Diptera, 32 Hymenoptera, 28 Coleoptera, 2 Cimicidæ, 12 other Rhynchota, 8 bots (from rhinoceros and hartebeest), 2097 ticks (17 species), 6 Linguatulidæ (from crocodile) and 96 parasitic worms ; all from North and West Nyasa.

Dr. R. E. Drake-Brockman :—52 Culicidæ, 2 *Lyperosia*, 3 *Hippobosca*, 4 Nycteribiidæ, 5 Streblidæ, 5 Siphonaptera, 2 Mallophaga and 14 Acari, from British Somaliland.

Major E. C. D'H. Fairtlough, C.M.G., D.S.O.:—8 *Tabanus argenteus*, from Sierra Leone.

Mr. C. C. Gowdey :—145 Coleoptera, 153 Hymenoptera Aculeata, 85 Hymenoptera Parasitica, 7 Orthoptera, 156 Diptera, 10 bots (from elephant), 20 species of Coccidæ, 26 other Rhynchota, 61 Lepidoptera, 58 ticks and 13 Myriapoda, from Uganda.

Dr. G. M. Gray :—11 Tabanidæ, 7 Hippoboscidæ, 2 other Diptera, 9 Lepidoptera, 3 Hymenoptera, 1 Coleopteron and 31 ticks, from Aro and Opelifa, Southern Nigeria.

Dr. H. Hearsey :—28 Cimicidæ, from Zomba, Nyasaland.

Capt. E. Hopkinson, D.S.O. :—4 *Glossina*, 8 Tabanidæ and 6 other Diptera, from the Gambia.

Mr. Harold H. King :—2 Culicidæ, 53 Tabanidæ, 2 *Lyperosia*, 20 *Simulium*, 3 bots (from Ariel Gazelle), 7 Hemiptera, 69 Anoplura, 207 Mallophaga and 24 Acari, from the Anglo-Egyptian Sudan.

Dr. W. A. Lamborn :—56 Tabanidæ, 12 *Glossina*, 3 other Diptera, 3 Hymenoptera and 1 earwig, from Oni River, S. Nigeria.

Mr. H. C. Macdonald :—56 ticks, from Mombera District, Nyasaland.

Dr. J. E. S. Old :—2 Culicidæ, 1 *Tabanus*, 1 *Stomoxys*, 5 Hippoboscidæ, 20 other Diptera and 33 dipterous larvæ (*Fannia*), from Blantyre, Nyasaland.

Dr. E. H. Allon Pask :—81 Tabanidæ, 32 *Glossina*, 2 Hippoboscidæ, 30 Anoplura, 422 ticks, 101 parasitic worms (from Eland), from Marimba District, Nyasaland.

Hon. N. Charles Rothschild :—13 Ixodidæ and 2 other Acari, from Aberdare Mts., 11,000 ft., British East Africa.

Mr. J. J. Simpson :—267 blood-sucking Diptera, 206 other Diptera, 190 Siphonaptera, 57 Hemiptera, 53 Homoptera, 19 Anoplura, 90 Mallophaga, 154 Hymenoptera Aculeata, 4 Hymenoptera Parasitica, 56 Coleoptera, 55 Orthoptera, 21 Neuroptera, 90 Lepidoptera and 120 Acari, from various localities in Southern Nigeria.

Dr. Hugh Stannus :—136 Tabanidæ, 6 *Glossina*, 3 Hippoboscidæ, 178 other Diptera, from West Nyasa.

Dr. Van Someren :—4 Mallophaga, 1 flea, 19 Acari and 5 worms (from Darter), from Kyetume, Uganda.

ON WEST AFRICAN TRYPETIDÆ (FRUIT FLIES).

By W. M. GRAHAM, M.B.,
Director of the Medical Research Institute, Lagos.

(Plates XI.–XIII.)

The family of the Trypetidæ is of great economic importance, for among its numerous genera are to be found many pests of the orchard and farm. The flies of this family are rarely brought to the notice of Europeans in West Africa, for there farming operations are entirely in the hands of the native population and the amount of damage done by these insects is perhaps insufficiently appreciated by Europeans; but from observations made in my own gardens, during a long West African experience, I believe the loss caused by their attacks must be considerable. The flies which are responsible for the damage observed belong to two genera—*Ceratitis*, MacLeay, and *Dacus*, Fabricius.

Ceratitis, MacLeay.

Small broad-winged flies, measuring from $\frac{3}{16}$ to $\frac{5}{16}$ inch in length.

During life, the eyes of all the local species I have seen are bright emerald-green, sometimes banded, and showing an iridescent play of colour. The wings are hyaline and ornamented with a distinct pattern of bands and spots, the spots being usually found on the basal third of the wing. The flies are found walking about upon the leaves or fruit of certain shrubs or trees, lazily waving their partly extended wings. The yellow head, green eyes and lazy movement of the wings make the flies remarkable objects. They cannot, however, be identified from these distinctions alone, for some species of the Ortalidæ resemble them in coloration and in the movements of the wings. From these latter the species of *Ceratitis* may be readily distinguished (among other characters) by the presence of four pairs of fronto-orbital bristles, extending the whole length of the forehead, from the vertex to the antennæ.

The female fly pierces the skin of the fruit with her ovipositor, and then lays her eggs in the fruit-pulp, where they hatch and become larvæ. The larvæ are elongated cream-coloured maggots. About the time that the larvæ are mature the infested fruit becomes rotten, and falls to the ground and usually bursts. The mature larvæ then leave the fruit, leap about upon the

ground, bury themselves in the earth, and become pupæ. The whole of the pupal stage is passed in the earth and lasts about 13 to 14 days. At the end of this time the flies issue from the pupa-cases and make their way up to the surface of the ground, expand and dry their wings, and fly away.

(See figure of *C. anonæ*, larva and pupa, Pl. XII, fig. 3.)

List of West African Species of Ceratitis.

Species.	Habitat.	Fruit Infested.
1. ♂ ♀ *C. capitata*, Wied., 1824	Almost cosmopolitan.	Almost any cultivated fruit.
2. ♂ ♀ *C. punctata*, Wied., 1824	Tropical Africa.	Cacao pods.
3. ♀ *C. bremii*, Guérin, 1843	Senegal.	?
4. ♀ *C. cosyra*, Walker, 1849	Congo.	?
5. ♂ *C. penicillata*, Bigot, 1891	Ivory Coast.	?
6. ♂ ♀ *C. anonæ*, Graham, 1908	S. Nigeria, Ashanti.	Soursop and guava.
7. ♀ *C. stictica*, Bezzi, 1909	Ashanti, Congo.	?
8. ♂ ♀ *C. nigra*, Graham, sp. n.	Ashanti, Lagos.	?
9. ♂ *C. inscripta*, Graham, sp. n.	Ashanti.	?

From the above table it will be seen how little is known of the West African species of this genus. In more than half the species a single sex only is described, and in most cases the habits of the fly and its larvæ are unknown.

Months of prevalence for Ceratitis *in W. Africa (so far as at present known).*

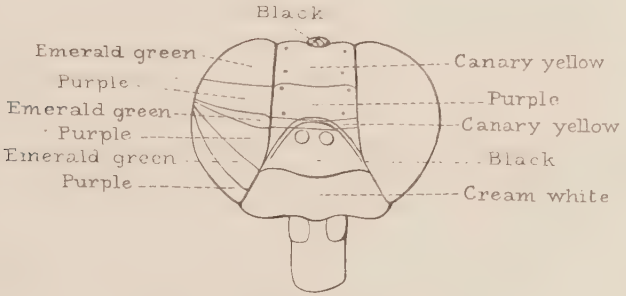
C. anonæ—July to November.
C. inscripta—November, December.
C. punctata—June, July.
C. stictica—July to November.
C. nigra—June to August.

Ceratitis nigra, sp. n. (Pl. XII, fig. 1.)

♀. Body shiny black; dorsum of thorax black, unmarked; abdomen black with one transverse grey band*; femora brown, tibiæ and tarsi yellow; wings hyaline, with brown banding and spotting.

* The additional white spots which appear on the abdomen in the figure, as well as all the white markings on the thorax, are due to reflections of light from the very shiny surface of the insect.

Head.- Upper two-thirds of front canary-yellow, ocellar spot black, fronto-orbital bristles black; lower third of front, frontal lunule, and insertion of antennæ brown. Face below antennæ brown, then cream-white to oral margin. Antennæ pale brown, arista dark brown, pale at base, plumose. Eyes dark purple-brown, palpi and proboscis pale brown. The head is coloured thus in dried specimens, but in life the colour scheme is very complicated and brilliant, as shown in the accompanying sketch.



Head of *Ceratitis nigra*, Graham.

Thorax shiny black: scutellum shiny black, with four black bristles and an indistinct yellow spot on the outer margins. *Abdomen* triangular, shiny black, with a broad transverse grey band occupying the median half of the 4th segment. Ovipositor black, convex above, flattened beneath, apex yellow, as long as the last three abdominal segments. *Legs*: femora dark brown, tibiæ and tarsi yellow. *Wings* hyaline, with a broad dark brown band covering the basal portion and extending along the costa to the apex of the wing, leaving behind a clear triangular area with its base on the posterior margin of the wing. From the apex of this triangle a narrow curved brown band crosses to the apex of the 5th longitudinal vein. Between the costa and the brown band is a clear, very narrow band extending the length of the marginal cell and expanding into two clear spots, where the 2nd vein reaches the costa. The wing is pale at its insertion, and there is a small triangular clear space lying between the humeral cross vein and the apex of the auxiliary vein, its base being on the costa, its apex on the 3rd vein. This space contains a dark spot in the costal cell and projections of brown colour enter the space from the sides, giving it a spotted appearance. *Halteres*, both stem and knob, brown.

Length 5·5 mm., excluding ovipositor; breadth across expanded wings 13 mm.

Taken upon the leaves of the oil-palm at Obuasi, South Ashanti, and at Yaba, Lagos, 2 P.M., 4.viii.09.

Type in the British Museum.

The male resembles the female very closely, but is slightly smaller. The legs are not flattened.

Length 5 mm.; breadth 13 mm.

Taken on window at Yaba, Lagos, 9 A.M., i.v.09.

Ceratitis inscripta, sp. n.

♂. Body black, dorsum of thorax grey, with black spots; abdomen black, with grey **W**-shaped design in middle; wings hyaline, banded and spotted with brown; femora brown, tibiæ and tarsi yellow.

Head. Front yellow with a **V**-shaped brown mark connecting the middle fronto-orbital bristles of either side, a black ocellar spot, a brown mark on frontal lunule and black bristles. Face cream-white, palpi buff with black hairs, proboscis brown. *Thorax* grey with shiny black margins, the dorsum with 3 longitudinal interrupted lines, the middle one formed of 3 elongated black spots, the lateral ones of 3 shorter black spots on either side. Humeri with 2 oval black spots outlined with yellow on each side. Scutellum shiny black, divided by yellow looped lines into 7 small areas; 5 along the margin and 2 above and in front. *Abdomen* triangular, black, with grey markings as follows: grey lateral apical spots and a thin grey apical band on the segments: in the median area a pair of triangles outlined in grey upon each segment, the whole series of these triangles forming a large letter **W**, its base standing upon the apical segment. *Legs*: femora brown, tibiæ and tarsi yellow. *Wings* hyaline, with brown markings; a broad brown band extends along the costa from slightly within the costal cell to beyond the apex of the wing. This band is interrupted along the costa between the 1st and 3rd longitudinal veins by five hyaline spots nearly equally apart. A broad brown band, nearly at right angles to the costal band, crosses the base of the wing, and passing through the basal half of the discal cell reaches the margin at the 6th longitudinal vein. Between these two bands a hyaline triangle is left, having its base upon the posterior margin of the wing, and its apex near the anterior cross vein. From this apex a narrow brown band crosses the hyaline triangle to the apex of the 5th longitudinal vein. *Halteres* with the stem yellow and the knob brownish.

Length 4 mm.; length of wing 3·5 mm.

Taken on window at Obuasi, South Ashanti, 24.xi.07.

Type in the British Museum.

Dacus, Fabricius.

Wasp-like flies measuring $\frac{1}{4}$ to $\frac{3}{8}$ inch long.

The body is usually brown or black with canary-yellow spots and lines; the wings clear, with usually, in West African species, two brown bands starting from the base of the wing: a broader band extending along the anterior margin, and a narrower one crossing the wing from the base at an oblique angle and ending at the posterior border.

In life the eyes are purple with dull green reflections. In dried specimens they become a dark purple-brown; and the scutellum, with the spots and lines upon the thorax, which in life are a canary-yellow, often become orange or brown, and the fine yellow lines almost disappear. The wasp-like appearance, caused by the spheroidal shape of the abdomen with its contracted waist and by the brown and yellow coloration, together with the clear wings, which are usually banded along the costa (front edge of wing), and the peculiar size and shape of the 2nd basal cell, should enable the flies of this genus to be readily recognised.

The habits of only two of the West African species are known. The females of *D. bipartitus* and *D. vertebratus* may be found, singly or in groups of 3 or 4, walking about upon the surface of young melons or vegetable marrows. Suddenly a fly ceases walking and remains stationary in one spot. If killed she will be found to have inserted her ovipositor through the skin of the fruit and deposited a little pile of eggs within. The eggs hatch into yellowish-white elongated maggots, which burrow in the pulp and grow until they are 10–11 mm. long by 2·5 mm. broad. Their presence causes the melon to rot, and the decay gradually extends outwards until it reaches the skin, appearing as a yellow area. Through the rotten portion, or upon the bursting of the fruit, the larvæ escape; they leap about upon the ground for a minute or two and then rapidly bury themselves, beyond the remains of the rotten fruit, a couple of inches deep in the ground. Here they enter the pupal stage. The pupa is an egg-shaped pale yellow body measuring 6·5 mm. long by 3 mm. broad. After about 15–16 days the flies leave the pupa-cases, make their way to the surface of the ground, expand and dry their wings, and fly away to repeat the process in another melon. The power of leaping possessed by the maggots is considerable and enables them to leap over the cordon of ants which is generally drawn round the rotten fruit. The advantage of this capacity for jumping is well seen by dropping a maggot among ants. Though at once attacked by the ants it usually manages to get rid of its assailants by a few violent leaps. The power may also be useful in enabling the larva rapidly to reach ground which is uncontaminated by the fruit-juices, for such contamination favours the growth of moulds, some of which may cause the death of the pupa.

It is further worthy of remark that the flies of both these species issue from the pupa-cases with unmarked wings, and that the brown banding only gradually appears during the expanding and drying of these organs.

List of West African Species of Dacus.

Species.	Habitat.	Fruit Infested.
1. ♀ *D. armatus*, F., 1805	Guinea.	
2. ♂ ♀ *D. testaceus*, Macq., 1835	Senegal.	
3. ♀ *D. bivittatus*, Bigot, 1858	Gaboon.	
4. ♂ ♀ *D. ciliatus*, Loew, 1862	Guinea.	
5. ♂ ♀ *D. punctulifrons*, Karsch, 1887.	Pungo-Adongo.	
6. ♂ *D. inornatus*, Bezzi, 1908	Congo.	
7. ♂ ♀ *D. vertebratus*, Bezzi, 1908	Eritrea, Lagos.	Musk and Blenheim orange-melons.
8. ♂ *D. mesomelas*, Bezzi, 1908	Congo, Lagos.	
9. ♂ ♀ *D. bipartitus*, Graham, sp. n. ..	Ashanti, Lagos.	Musk and Blenheim orange-melons, vegetable marrows, cucumbers.
10. ♀ *D. flavicrus*, Graham, sp. n. ..	Lagos.	
11. ♀ *D. fuscovittatus*, Graham, sp. n.	Lagos.	

It will be seen that in more than half of the species one sex only is known, and that the habits of but two species have been recorded. As in the case of *Ceratitis*, the species of this genus are known to attack a great variety of cultivated fruits and vegetables in other parts of the world, as the following list will show :— peach, orange, mango, guava, banana, pineapple, granadilla, olive, tomato, cucumber, melon, marrow and string beans.

In both Ashanti and Lagos the attacks of *Dacus* render it impossible to rear melons or allied vegetables in the open during the rainy season. They can only be grown by protecting the plant with a frame covered with mosquito-netting, or by enclosing the fruit in oiled paper bags. At Yaba (Lagos) Blenheim orange-melons planted in April (beginning of rains) produced uninfected fruit, but of the same kind of melons planted in August not a single one escaped infection.

Months of prevalence for Dacus *in West Africa (so far as at present known).*

D. bipartitus—August to November.
D. flavicans—March.
D. fuscovittatus—September.
D. mesomelas—March.
D. vertebratus—September, October.

As Professor M. Bezzi's original descriptions of *D. vertebratus* and *D. mesomelas* are in Italian and Latin and unlikely to be accessible to readers in West Africa, I have added translations so as to complete the descriptions of the figures given in the plates.

Dacus vertebratus, Bezzi. (Pl. XIII, figs. 3 & 4.)

Reddish brown, spotted, palpi and antennæ yellowish, face with two broad black spots, front with median spot and three dark orbital spots and a dark mark beneath the eyes on the oral margin. On the dorsum of the thorax three triangular black marks, the marks on the humeri, the mesopleural sutures and the scutellum yellow, and two yellow spots behind the root of the wings. Abdomen rounded, with the apex obtuse ; a median longitudinal line and transverse lateral marks black. Legs yellow, with the apex of the femora, the tibiæ and the distal segments of the tarsus darkened. Wings hyaline, with a narrow band along the anterior margin, dilated at the apex into a spot, and a dark band on the anal cell.

♂. The third segment of the abdomen with nine or ten black bristles upon the posterior margin.

♀. Ovipositor short, base swollen, cylindrical.

Length of body 6–7 mm., wings $5\frac{1}{2}$–6 mm.

Dacus mesomelas, Bezzi. (Pl. XII, fig. 2.)

♂. Black, head and thorax with ferruginous spots. Face below with two circular black spots. Scutellum yellow, with a broad median longitudinal black band. Abdomen with a broad longitudinal ferruginous band divided by a fine black line. Legs yellowish, the posterior tibiæ black. Wings hyaline, with a narrow dark streak along the costa and the anal cell, and a very small dark spot at the apex of the third vein. A single yellow spot on hypopleura. Sides of abdomen without bristles.

Length of body 6·5 mm., wing 5·5 mm.

Dacus bipartitus, sp. n. (Pl. XIII, figs. 1 & 2.)

Brown ; head buff ; thorax dark brown, with three yellow stripes behind the transverse suture ; scutellum yellow ; abdomen dark brown, with two yellow transverse bands, the broader being on the apical half of the second segment. Wings hyaline, with broad brown costal and anal bands.

Head. Occiput pale brown, with yellow orbits. Front buff, with three pairs of brown orbital spots and a median brown spot, the four corners of which are connected with the two lower pairs of orbital spots ; ocellar spot dark brown ; face yellow, with two large black spots and a brown spot

beneath each eye. Eyes in life purple, with a blue-green iridescence. Antennæ pale brown, the third joint darker externally and at the tip ; arista brown, with pale base. Palpi and proboscis yellow. *Thorax* dark brown, paler at margins, covered with a greyish tomentum and with three slightly divergent dark striæ varying in distinctness in different specimens. Behind the transverse suture the median line is occupied by a canary-yellow stripe not reaching the scutellum and sometimes indistinct ; on each side of it is a curved yellow stripe, not reaching the scutellum. Scutellum yellow, with two black bristles. Pleura brown, crossed by a broad yellow band from the end of the transverse suture to the sternopleura, where it ends as a small spot. Hypopleura with two canary-yellow spots of nearly equal size. *Abdomen* dark brown, spheroidal ; first segment with a very narrow apical transverse yellow band ; second segment with a transverse broad yellow band occupying apical half ; an indistinct dorso-median dark line on the third, fourth and fifth segments, and two paler, somewhat depressed, areas upon the apex. Venter with the basal half pale, the apical half brown, and with four brown median spots. *Legs* with the coxæ dark brown ; femora yellow, with the apical half brown on the fore and mid pairs and the apical third brown on the hind pair ; tibiæ brown ; first tarsal joint yellow, remaining joints brown. *Wings* hyaline, with dark brown veins. A broad brown band extends along the costa to the tip of the third vein, expanding so as to fill the anterior half of the first posterior cell ; a brown band covers the anal cell and overflows into the third posterior cell. *Halteres* with semitransparent greyish knobs and yellow stems.

♀. Ovipositor shiny brown, cylindrical, with dilated base as long as last two abdominal segments.

Length of body 8·5–9 mm., wing 8 mm.

♂. 12 to 16 black bristles upon the apical lateral margins of the third segment.

Length of body 7·5–8 mm., wing 7 mm.

Type in the British Museum.

I have retained for this species the MS. name given to it by Walker in the British Museum collection.

Dacus flavicrus, sp. n. (Pl. XII, fig. 4.)

Brown ; head yellow ; thorax dark brown, with black markings and yellow bands on the transverse suture ; scutellum yellow ; abdomen brown, with a black dorso-median line. All femora and 1st tarsal joints yellow ; tibiæ and tarsi brown. Wings hyaline, with narrow brown costal and anal bands.

♀. *Head* : Occiput pale brown with yellow orbits ; front yellow, lower end brownish, with 3 pairs of brown orbital spots, a brown spot on the frontal

lunule, a large black spot on each side of the face and a small brown spot beneath each eye. Eyes purple, with dull greenish sheen. Antennæ pale brown, the third joint buff on internal aspect; arista dark brown with pale base. Palpi and proboscis buff. *Thorax* with the dorsum dark brown with black markings, humeri canary-yellow and a yellow band on each side lying along the outer portions of the transverse suture. Pleura dark brown, crossed by a broad yellow band which ends in a spot on the sternopleura. Hypopleura with two yellow spots, the lower spot being much the larger. Scutellum yellow, with two dark brown bristles. *Abdomen* pale brown, with some darker irregular marks and a dorso-median black line from the third segment to the apex, where it becomes somewhat broader. Venter brown, pale at the apex. *Legs*: femora yellow, tibiæ dark brown, first joint of tarsi yellow, remaining joints brown. *Wings* hyaline, with a brown costal band divided at the base of the wing so as to leave the costal and subcostal cells clear, and then extending between the costa and the 2nd longitudinal vein until it crosses the apex of this vein, when it becomes slightly wider and extends to a short distance beyond the apex of the 3rd longitudinal vein. Anal cell brown to the edge of the wing, the brown colour spreading into the 3rd posterior cell. *Halteres* entirely cream-white.

♀. Ovipositor short, pale brown, flattened.

Length of body 7 mm., wing 5 mm.

Described from a female taken on a window at Yaba, Lagos, 3 P.M., 25.iii.1909.

Type in the British Museum.

Dacus fuscovittatus, sp. n. (Pl. XII, fig. 5.)

Pale brown; head yellow; thorax pale brown with black and yellow markings, scutellum yellow; abdomen dark brown laterally, with a broad median longitudinal yellow band and a black dorso-median line. Legs with the femora yellow with brown spaces; tibiæ brown, tarsi brown with the first joint yellow. Wings hyaline, with a costal brown band, enlarged at the apex, and a narrow anal band.

Head. Occiput brown with yellow orbits; front yellow, with 3 pairs of brown orbital spots and a brown median spot uniting the two lower pairs of orbital spots; vertex dark brown; face yellow, with an oval vertically elongated black spot on each side. Antennæ brown, third joint pale on internal aspect; arista brown with yellow base. Palpi and proboscis yellow. *Thorax* pale brown; in front of the transverse suture is a median broad black band with a triangular black spot on either side and a broad yellow lateral band on each side along the suture towards the root of the wing; behind the suture are 3 yellow stripes, the median one straight, the lateral ones curved

and enclosing a large black mark, divided longitudinally by a stria, on either side of the thorax. Scutellum yellow with 2 black bristles. Pleura dark brown, crossed by a broad yellow band which ends in a nearly circular spot on the sternopleura. Hypopleura with two yellow spots of nearly equal size. *Abdomen* elongate, with obtuse apex; 1st segment dark brown with a yellow apical transverse line; 2nd segment mostly yellow, with brown lateral margins; remainder of abdomen dark brown laterally, with a median broad longitudinal yellowish band to the apex where it expands into a nearly circular pale area. Down the middle of this band runs a dark brown, narrow, longitudinal stripe the whole length of the abdomen. Venter pale brown with 3 median brown spots. *Legs* with the coxæ dark brown, femora yellow with the apical third brown, tibiæ dark brown, tarsi brown with the first joint yellow. *Wings* hyaline with pale brown veins. A brown costal band divides at the base of the wing so as to leave the costal, and half the subcostal, cell clear yellow, it then narrows, leaving the basal half of 1st posterior cell a clear yellow, and then expands into a large brown area covering the apex of the wing and extending across it into the 2nd posterior cell. Anal cell covered by a brown band extending to the edge of the wing and into the 3rd posterior cell. *Halteres*: knob semitransparent white, stem white.

♀. Ovipositor pale brown, cylindrical, with expanded base.

Length of body 8 mm., wing 6·5 mm.

Described from a female taken on a wall in the garden at Yaba, Lagos, at 5 P.M., 12.ix.1909.

Type in the British Museum.

Remedial Measures.

On the subject of prevention a similar statement will apply equally well to both *Ceratitis* and *Dacus*. A fruit infected by these flies cannot be cured, and is a source of infection; it should therefore be destroyed and care should be taken to do so early enough to ensure the destruction of all the contained maggots, before they escape into the earth.

If the native fruits infected by these flies were identified, and when infected destroyed, the flies could be greatly diminished in the course of a couple of seasons.

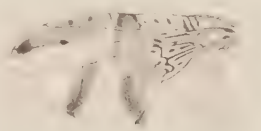
Infected fruit can be destroyed by burning or boiling. When the amount is large and these means of destruction are not available, it is only necessary to bury the infected fruit deep enough to prevent the fly, when it leaves the pupa-case, from reaching the surface. A depth of two feet should be sufficient to ensure this, especially if the earth filled in over the fruit is well trampled down.

Yaba, 28.v.10.

1. Ceratitis anonæ, Graham, ♂. × 5·7.

2. Ceratitis capitata, Wied, ♀. × 6.

3. C. capitata, Wied, ♀. × 6.



4. Wing of C. capitata, Wied. × 6.

5. Ceratitis anonæ, Graham, ♀. × 5·7.

WEST AFRICAN FRUIT FLIES
(TRYPETIDÆ).

1. Ceratitis nigra, Graham,
♀. × 4.

2. Dacus mesomelas, Bezzi,
♂. × 4.

3. Ceratitis anonæ, Graham.
Larva and Pupa. × 5.

4. Dacus flavicrus, Graham,
♀. × 4.

5. Dacus fuscovittatus, Graham,
♀. × 4.

W. M. Graham *phot.*

WEST AFRICAN FRUIT FLIES
(TRYPETIDÆ).

1. Dacus bipartitus, Graham, ♂. × 4.

3. Dacus vertebratus, Bezzi, ♀. × 4.

4. Dacus vertebratus, Bezzi, ♂. × 4.

2. Dacus bipartitus, Graham, ♀. × 4.

W. M Graham *phot.*

WEST AFRICAN FRUIT FLIES (TRYPETIDÆ).

[Probably the most effective remedy for the fruit-fly pest is that devised by Mr. C. W. Mally, Entomologist for the Eastern Province, Cape Colony which aims at destroying the adult flies by means of a sweetened poison, which is very lightly sprinkled over the trees that are liable to attack. The spray fluid recommended by Mr. Mally, after many experiments, is :—

Sugar	2½ lbs.
Paste Arsenate of Lead	3 oz.
Water	4 gallons.

The liquid is applied with an ordinary garden syringe having a very fine spray attachment. Only a very small quantity should be applied, a pint to a pint and a half being sufficient for a large peach tree. Fuller details will be found in the Cape Agricultural Journal for November 1909 ; and as an indication of the practical value of the remedy, it is there stated that "a severe outbreak of the pest in a commercial peach orchard was brought to a sudden and practically complete halt. The infestation of the fruit on the treated trees fell from over 50 per cent. to less than 1 per cent., while that of untreated trees a few hundred yards away increased until practically every fruit was involved."—Ed.]

NOTES ON THE HABITS OF *GLOSSINA MORSITANS* IN NYASALAND AND THE ADJOINING TERRITORIES.

By Sir ALFRED SHARPE, K.C.M.G., C.B.,
Governor of the Nyasaland Protectorate.

Throughout the Nyasaland Protectorate there are many areas which are infested by *Glossina morsitans*; and this species is also to be found in North Eastern Rhodesia, and in German and Portuguese territory bordering on Lake Nyasa. I have been frequently through all these territories during the last 22 years, and know them well.

From my observations, made very carefully during the last six or eight years, the opinion I have arrived at in every case is that fly-areas have neither diminished nor increased during the time I have known the country. It is impossible to say what are the exact conditions which are suitable in any district for the existence of tsetse-fly. Within a fly-area it does not follow that fly will be found throughout, nor on all days, nor at all seasons. To speak of a "fly-*belt*" gives a wrong impression. A "fly-area" has more or less definite limits, and within this area fly may be found, sometimes in one part, sometimes in another.* It is possible to go through a fly-area many miles in extent on some occasions without meeting much fly; on other occasions they may be found thickly throughout. The season of the year has a great deal to do with this, but there are other causes which it is impossible, as yet, to define. For example, between the settlement of Zomba and the Mlanje Mountains, a distance of about 40 miles, lies an extensive plain. Horses or cattle can be driven across from Zomba during the months of May or June without meeting any fly at all; later in the year, say October, they would have to pass through about 25 miles of fly. On the advent of the first rains in November there is a noticeable diminution of fly, but they are still found more or less in this particular area until the arrival of the cold weather in April and May.

My own opinion, which I have expressed on various occasions before now, is that the existence of wild game has very little, if anything, to do with the

* [The fact that the terms "fly-belt" and "fly-area" are frequently used as though they were interchangeable is apt to cause confusion. It would be well therefore to restrict the term "fly-belt" to country in which *Glossina* is actually existent; whereas the word "fly-area" would have a wider sense, signifying a district which is liable to be infested by tsetse, either wholly or in part. Thus evidence as to the alteration of fly-belts would not necessarily be in conflict with the author's view that the limits of fly-areas are stable.—Ed.]

existence of any species of tsetse-fly. At the time when rinderpest visited Nyasaland, there was a noticeable decrease in the quantity of big game in some of the districts where tsetse-fly exists, especially as regards buffalo, but I have never noticed that this had any effect on the presence of *Glossina*. In Nyasaland the common kind of tsetse is *Glossina morsitans*. In certain areas *fusca* is found, but no *palpalis*.

Within a fly-area, as already stated, the quantity of fly met with varies at different times of the year, and I am inclined to think that the prevalence of strong winds to some extent drives the insects away. I have not noticed that any special soil, bush or herbage seems to attract them. So far as *morsitans* is concerned it is certain that water is no attraction to them; nor have I observed that the presence of fly is in any way associated with sand. In Nyasaland, *Glossina* is never found in open grass country; it is only found in bush, not necessarily dense forest, but country scattered with trees which give shade. *G. morsitans* is seldom found above 3000 feet in Nyasaland.

While I hesitate to give a decided opinion on the question whether *morsitans* is entirely dependent for its existence upon the blood of wild mammals, a point which is perhaps better answered by scientific men, yet I can say that out of innumerable tsetse which I have caught I have never found one which had any trace of blood in the abdomen, with the exception of flies caught in the act of feeding either upon myself, upon natives or animals; and the impression which I have formed is that tsetse-fly are no more actually dependent upon the blood of mammals for their existence than are mosquitos. Unless I am right in this opinion, I am at a loss to understand how the enormous numbers of tsetse-fly which are found in some areas can exist, as in many of those areas game is either extremely scarce or almost non-existent. In Nyasaland it is distinctly noticeable that many of the fly-areas are almost destitute of game, whereas, on the other hand, some parts of the country where game is most abundant, such as the valley of the Rukuru River, are entirely free from tsetse; and in this locality, as in others, buffalo are fairly abundant. At the north end of Lake Nyasa, before the advent of rinderpest, there were many thousands of buffalo, but no *morsitans*.

I am acquainted with villages which are situated inside fly-areas, and wherever the natives build their villages in such localities, and clear ground for their food-gardens, tsetse immediately disappear from the cleared ground. I have often noticed that, when approaching these villages from the bush, fly which are following the carriers, or are actually upon their persons biting them, will gradually disappear after entering the cleared ground, and by the time the village is reached, no fly can be seen. On the other hand, I have known cases where villages have been abandoned, and after a time, as the

natural bush has grown up, the flies have reappeared in places where the native food-plantations formerly were.

I have known many cases, especially in the country lying between Tanganyika and Mweru, where native villages situated in fly-areas have possessed cattle, noticeably so in the case of the powerful chief Nsama. In these instances the cattle were always kept either inside the village itself, or else were only allowed to feed immediately outside, and were always herded by boys to prevent their straying into the bush. Goats, however, are found in all villages in Nyasaland, whether in fly-areas or not, and it is certain that the bite of *morsitans* may have little or no effect upon these animals. On the other hand, I have been informed by natives living in fly-areas that if goats are brought by them from other districts where no tsetse-fly exist, they frequently sicken and die. I cannot myself vouch for the truth of this.

Generally, it will be gathered from the foregoing remarks that my opinion is that the presence or absence of big game has little or nothing to do with the existence of fly. I know that this opinion does not coincide with that of Mr. Selous, whose experience is, I think, principally confined to Africa south of the Zambesi. I can only say, however, that my observations during the last six or eight years have been very carefully made, that the conclusions I have given have been very carefully arrived at, and that they are shared, I think, by many careful observers in Central Africa.

Statements are made from time to time by persons who may even have spent some years in Tropical Africa—notably so in Nyasaland—that tsetse-fly is "spreading." As already stated, I do not think that "fly-areas" alter their limits to any appreciable extent. Those who make these statements do so no doubt because they honestly believe them to be true, but I know from personal experience that in many cases fly has existed in the supposed new areas for the past twenty years. There are various causes for fly being now more noticed:—More attention than formerly has been called to the subject; cattle are now kept by natives in districts where formerly, owing to wars and raids, there were none; large native settlements have altered their locations (notably at Fort Johnston, at the south end of Lake Nyasa), and as the old clearings grew up fly appeared. Increased transport by ox-waggons has revealed the existence of fly also in places where it was not noticed before.

WEST AFRICAN HEMIPTERA INJURIOUS TO COCOA.

By GERALD C. DUDGEON,
Inspector of Agriculture for British West Africa.

In the Bulletin of Entomological Research, Vol. I. pp. 60–61, I gave an account of the ravages of a cocoa bark-sapper (*Sahlbergella theobroma*, Dist.), which was found destroying cocoa trees upon plantations in some parts of the Gold Coast and Ashanti, where, by reason of its wide distribution in 1909, it promised to affect the industry seriously.

In January 1910 I again visited Bompata (Ashanti), one of the localities where the pest had been prevalent during the previous spring, and found that, although the black bark-sapper (*S. theobroma*) did not seem quite so plentiful, a very nearly allied species (*S. singularis*, Hagl.) was present upon almost every tree in badly infested plantations. This species is distinguished from the last by the light brown colour and the brown mottling of the hemielytra as well as by the slightly different form of the antennæ.

The habits of the two species are similar and their responsibility for the destruction of the trees has been recognised even by the native cocoa-planters at Bompata. The officers of the Agricultural Department have frequently visited this locality and have demonstrated this fact as well as the correct application of the remedial measures which have been recommended.

Experimenting with kerosene emulsion, I found that if a large quantity of soap were used the syringes soon became clogged, and the following preparation was tried and found the most suitable :—One pound of soap was dissolved by boiling in two gallons of water to which, while hot, four gallons of kerosene were added and thoroughly mixed by syringing. One part of this stock solution was mixed with nine parts of water for use when spraying. This last, sprayed upon living immature insects upon the trees caused them to run to shelter into bark crevices, in which after three or four minutes they were found to be killed. As the insects are said to congregate upon the trunks of the trees in the early morning, this time seems indicated as that most suitable for spraying.

The pest has extended to the west of Kumassi, where cocoa has only been planted to a small extent at present, but where insufficient care seems to have been given with regard to weeding and keeping the plantations clean. An examination of the stems attacked by the sappers showed that there was frequently an exudation of a gelatinous substance, and indications of the presence of fungoid disease in the cambium were found.

THE INVESTIGATION INTO THE ORIGIN OF SLEEPING SICKNESS INFECTION IN THE LUANGWA VALLEY.

Reports have recently been received with reference to the search for *Glossina palpalis* which has been initiated by the Administration of North Western Rhodesia along the lower half of the Luangwa River and some of its western affluents, in the hopes of tracing the origin of various cases of sleeping sickness which have recently been discovered in this area. But up to last June no trace of *palpalis* had been found by either Dr. H. Leach or Mr. Silverlock, after some months of independent investigation.

Dr. Leach began his search as long ago as January last, on the Nyamadzi River, which enters the Luangwa from the west near 12° S. lat. Every ford and village along the river was systematically examined, but although the conditions appeared generally favourable for *palpalis*, not a single fly was found. Yet three cases of sleeping sickness were detected among the resident natives. *Glossina morsitans* and species of *Hæmatopota* and *Tabanus* were observed to be numerous along the whole course of this river. The whole length of the Luangwa was then traversed in a canoe, from the Nyamadzi to the Zambesi, every village near the banks being visited, and a week was spent in examining the Kaombi and Likasashi rivers, which are tributaries from the west. From Feira, Dr. Leach continued his search for over 100 miles up the Zambesi to the mouth of the Kafue, and for another 20 miles up that river.

Mr. Silverlock independently followed a similar course on the Zambesi, but on the Luangwa his search was confined to the southern portion, between Hargreaves and Feira. Both observers note that there was a marked diminution in the numbers of biting flies of all kinds as the dry season progressed.

Dr. A. May, Principal Medical Officer for North Western Rhodesia, makes the following comments with regard to the present investigation :—

"Two portions of the Luangwa Valley are therefore under suspicion as providing an agent for the spread of the disease : the northern portion in the vicinity of Nawalia [on the Nyamadzi River], and the southern vicinity of Hargreaves, and for some distance south. The intervening portion of the river, a distance of some 200 miles, is, in Dr. Leach's opinion, unfavourable for harbouring *G. palpalis*. Between the junction of the Lusenfwa with the Luangwa and the Zambesi, the conditions are also reported as unfavourable for carrying *palpalis*.

"The history of a great proportion of the infected natives fails to show that there had previously been any possibility of infection having taken place in a known *palpalis* area. There is in fact reliable evidence in many of the cases to justify any possibility of infection from a known *palpalis* area being disregarded.

"*G. palpalis* has not been found on any part of the river by Dr. Leach after a very careful search, nor by Dr. Leach and many other observers in the case of that portion of the river between Chewanda's and Hargreaves. It is, however, notable that those cases of the disease which have been found occurred in close proximity to the river or its tributaries, in parts where conditions were more or less favourable for harbouring this species, and that no cases were found in parts where conditions were unfavourable, although in both cases careful search failed to reveal the presence of this fly.

"Dr. Leach has advanced a theory which tends to fit in with these facts, but which has not as yet been fully investigated. He suggests that in the main stream at the time of the year at which his recent investigations were carried out, while all the conditions as to shade, etc., suitable for harbouring *palpalis* were present, the water level was at that time so high as to very much limit the extent of suitable breeding ground, and for that reason the fly may have migrated to some of the tributaries which have as yet only been examined for a short distance from their openings into the main stream. It seems probable that for this, or some other reason, the fly may migrate at certain seasons from the main stream to its smaller tributaries, and this would account for the negative results of Dr. Leach's and Mr. Silverlock's search.

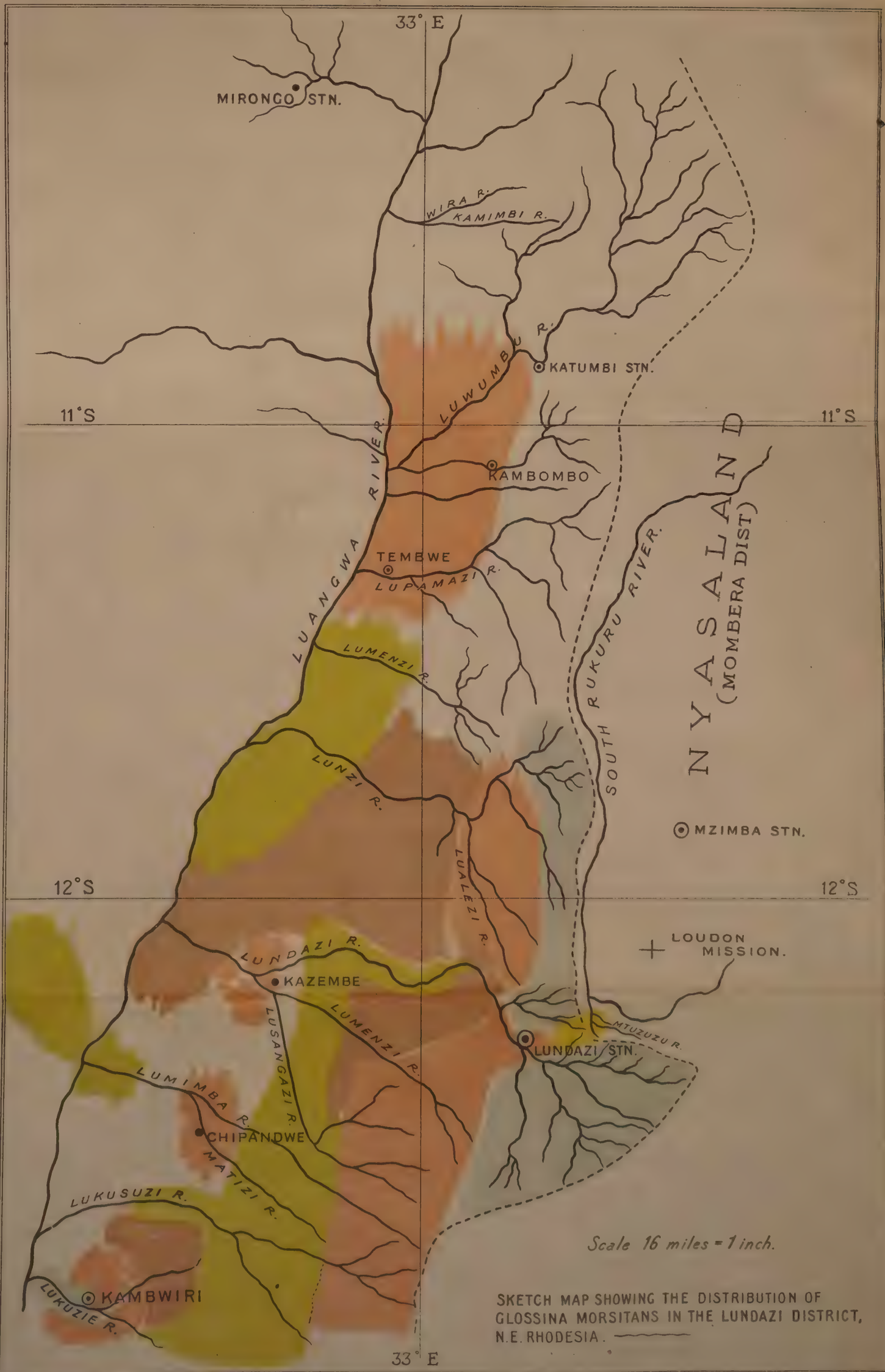
"The possibility of infection being conveyed by some species other than *G. palpalis* must not be lost sight of, and should a further search at a different season of the year fail to reveal the presence of this species, it will then be desirable to institute experiments, as suggested by Dr. Bagshawe (Sleeping Sickness Bulletin, no. 17), to test whether any other biting flies which exist in these localities may be capable of transmitting the disease."

It is notable that in these reports no mention is made of *Glossina fusca*, although this large species has been recorded as occurring in the vicinity of Hargreaves (Sleeping Sickness Bulletin, no. 16, p. 146). But the fact that this insect was not seen by Dr. Leach or Mr. Silverlock does not necessarily constitute clear evidence as to its non-existence in the route which they followed; for while *palpalis* is a species of markedly obtrusive habits, it is well known that *fusca* is very liable to be overlooked by collectors (unless specially searched for), owing to its unusual habit of concealing itself during the day.

With regard to Dr. May's remark that the cases of sleeping sickness in

this area were found only in localities suitable for the occurrence of *palpalis*, it may be recalled that the physical conditions which are specially suitable for *palpalis* are equally necessary for *fusca*. Moreover, although the non-existence of *palpalis* in the Luangwa Valley is very far from being established, yet there are considerations which render such a conclusion at least probable. For, as Mr. S. A. Neave has pointed out (Journal of Economic Biology, 1909, p. 110), the watershed, which in Northern Rhodesia separates the river-system of the Congo from that of the Zambesi, also constitutes a well-marked zoological boundary. The insect-fauna of the country drained by the Congo presents a strong infusion of forms which are peculiarly characteristic of Tropical West Africa; while on the Zambesi side of the watershed the insect life is thoroughly typical of the East African fauna. Now, as Neave has remarked, wherever *palpalis* has been found up to the present it has invariably been associated with an insect-fauna of the West African type. From the large entomological collections made by Neave himself in the Luangwa Valley, we are able to say with some degree of certainty that the insect-fauna of that area is purely East African in character, being quite similar to that of Northern Mashonaland; and the discovery of *palpalis* in such surroundings would therefore be somewhat surprising.

Early in July the Entomological Research Committee requested Mr. Neave to proceed to the lower Luangwa for the express purpose of collecting and observing the species of *Glossina* which may occur there.



SKETCH MAP SHOWING THE DISTRIBUTION OF GLOSSINA MORSITANS IN THE LUNDAZI DISTRICT, N.E. RHODESIA.

WEST, NEWMAN, LITHO.

NOTES ON THE MOVEMENTS OF *GLOSSINA MORSITANS* IN THE LUNDAZI DISTRICT, NORTH EASTERN RHODESIA.

By P. E. HALL, Native Commissioner, Lundazi.

(With Sketch-Map.)

At the suggestion of Mr. S. A. Neave, I have prepared the following brief notes of my observations on the changes in the distribution of *Glossina morsitans* within the Lundazi District.

I came to this district (then known as the Nawalia District) in September 1904; I left it in March 1907, and returned to it again in January 1909. From the time I came to the district I have always been on the watch for, and noted the presence of, tsetse.

In the attached sketch-map I show :—

(1.) Areas where I found fly in 1904–5–6, coloured GREEN; all this area is still fly-infested.

(2.) Areas which, to the best of my knowledge, were clear of fly up to the end of 1906, but which are now fly-infested, coloured PINK. The negative evidence is always my own observation, plus statements of the villagers (not very valuable; for again and again when they have said there were no tsetse, I have found some in a short while)—and generally reinforced by the presence of native cattle in good condition. The PINK patch extending northward from Tembwe's, on the Lupamazi River, I have inserted on the authority of Mr. H. Forsyth, a farmer near Fife and Chinsali, who brought a large herd of cattle down through that region in 1905, and who has been hunting elephant in the same area this year. I think complete reliance can be placed on Mr. Forsyth's statements.

(3.) A small YELLOW patch, east of Lundazi Boma, extending across the Nyasaland border to an open marshy "dambo" stream, Mtuzuzu, draining to the South Rukuru River. This was most certainly clear of tsetse a year ago, and the cattle in that area appear to be still in good health; but I have been out there twice this month on a track I am clearing to Loudon Mission, and each time I have seen a specimen or two on the Mtuzuzu.

(4.) The MAUVE areas represent those which are now fly-infested, but of which I am unable to say definitely that they were or were not infested in 1906 and earlier.

(5.) The BLUE colour signifies areas which are still clear, to the best of my knowledge.

(6.) Areas about which I have no knowledge are left blank.

My district is bounded by the Luangwa on the west, the Wira and Kamimbi to the north, Nyasaland on the east, and by Fort Jameson District (13° 5′) on the south.

The old Nawalia station on the Nyamadzi River, west of the Luangwa (about 12° 25′ S.), was free from fly until 1904; there was always a small herd of Government cattle there. About the middle of 1904 there was an alarm of tsetse having spread into the neighbourhood, and the cattle were sent away. In 1905–6 I occasionally saw a specimen in the police lines, but never one actually at my residence. I am told by Europeans that now the old lines (which have become a native village) are full of fly, and there are usually some also about my old quarters.

In the south end of my district the fly has spread a good deal, up the Lukuzi River; it first appeared about Masumba's in 1904 (10¾ miles upstream from Kambwiri's); in 1906–7 it appeared at Chinunda's, and the cattle there died; and last year I saw it for about 5 or 6 miles along the road from Chinunda's towards Fort Jameson.

Mr. Forsyth tells me that the natives about the Luwumbu River, where he has been hunting, say that before the rinderpest (in the early "90's") game was very abundant indeed, especially buffalo, and there were great quantities of fly; but after the rinderpest there was almost no game at all, and the fly disappeared at once; from that time to this the game has been coming in again and constantly increasing, and the fly has spread every year. This is exactly what the natives round Nawalia told me in 1904–5; they especially mentioned the amount of wildebeeste, and spoke of the fly as a plague even in the villages.

The Rev. D. Fraser, of Loudon, has told me that my northernmost GREEN patch was a fly-free country, with several small herds of cattle, about 10 years ago. He also tells me that, according to the natives, the whole course of the Rukuru River (parallel with my eastern border) was fly-infested about 20 or 25 years ago; it is now one line of cattle-owning villages. He does not know whether the change coincided with the rinderpest. There is little or no large game along the Rukuru, as the Angoni are constant and energetic hunters.

SOME FURTHER OBSERVATIONS ON THE SCALE INSECTS (COCCIDÆ) OF THE UGANDA PROTECTORATE.

By ROBERT NEWSTEAD, M.Sc., A.L.S., &c.,
Liverpool School of Tropical Medicine, University of Liverpool.

Mr. C. C. Gowdey, the Government Entomologist of Uganda, is to be congratulated upon the number of interesting forms which he has forwarded to this country for identification from time to time. Many of the species, if not all, are of economic importance, and, judging by their numbers, must have sorely taxed the plants upon which they were found.

One of the most remarkable facts connected with the Coccids from the Uganda Protectorate is that a very large percentage of them has been parasitized by small Chalcidids. I have never before seen so many individuals destroyed by these parasites from any other part of the world. A study of the bionomics of these insects would no doubt prove of great interest from an economic as well as from a biological standpoint; and it is to be hoped that it will be possible in the future to give some attention to this interesting group of the Hymenoptera.

Inglisia conchiformis, sp. n.

Test of adult female (fig. 1) shaped like a miniature bivalve shell, standing erect upon the branch of its food-plant, with the hinge uppermost and its lower edges resting upon a pad of white secretion, which often projects beyond the test, forming a narrow flocculent fringe; surface of test with distinct vertical striæ; pale horn-colour, with confluent streaks of golden-yellow and brown-yellow.

Length 5–6·5 mm.; width 1·5–2·5 mm.; height 2·5–3·5 mm.

Female, adult.—Very elongate; margin with a narrow band of stout conical spines, consisting of three or four irregular rows in front and behind, but merging into two at the sides. Stigmatic areas with a few additional spines between which are a number of circular spinnerets. Antennæ and legs short, the former of seven segments. *Tarsi with a deep pseudo-articulation.*

Length 5 mm. (average).

Puparium of male.—Opaque glassy-white, surface somewhat scaly; margin with an irregular fringe of stout glassy-white filaments. Shape somewhat like the puparia of the genus *Lecanium*, but the so-called "coronet" is not clearly defined.

Larva ellipsoidal, but narrowing posteriorly. Antennæ relatively short, being scarcely half the length of the legs; segments six in number, the third longest and stoutest. Legs very long, normal. Anal lobes large

each bearing one very long hair, almost equal in length to the body, and 3–4 short hairs of varying length. Margin with a regular series of conical spines, widely separated. Stigmatic areas each with a single curved *spine of great length*.

This very singular coccid was first discovered by Dr. Slater Jackson in the Jardin Botanique, Konakry, West Africa, on *Averrhoa carambola*, L.,

Fig. 1.—*Inglisia conchiformis*, Newst.; adult females. ×2.

November to January 1907–8, and said by him to be "abundant on the terminal branches." Soon after the material came into my hands I found that the insect was undescribed, and I then gave it the manuscript name *Onicococcus conchiformis* (gen. et sp. n.); specimens were forwarded to the British Museum and to other collections under this name, but no description has hitherto been given by me. Mr. E. E. Green, who has

recently received specimens from the Uganda Protectorate (C. C. Gowdey), informs me that this insect is undoubtedly a species of *Inglisia*.

The examples which were forwarded recently by Mr. C. C. Gowdey were taken by him in the Royal Botanical Gardens, Entebbe, on *Harogana madagascariensis*, 7.iv.10 (no. 1432).

The examples of the male puparia had nearly all been parasitized; and a large percentage of the females had been destroyed by the larvæ of a small Noctuid moth, which Sir George Hampson has identified as *Eublemma scitula*, Ramb. (Subfam. Erastriinæ), an example of which had hatched out during transit. This moth has a very wide range, occurring in the south of Europe, in India and throughout Africa. In Cape Colony, Mr. C. P. Lounsbury has bred it from *Lecanium hesperidum*, L.

Lecanium mori, var. **somereni**, nov.

Resembles *Lecanium mori*, Signoret, in shape and colour; but has a brightly polished surface and the margin is turned outwards, forming a distinct and strongly defined carina all round the body of the insect. It also differs from typical *L. mori* in having eight segments to the antennæ; a character which is quite constant in all the examples prepared for microscopical examination. Marginal spines slightly dilated and frayed at the ends. Anal plates short, length slightly greater than the width. Derm glands slightly larger and more numerous at the thickened margin than elsewhere.

Length 3·50–4 mm.; width 2–2·50 mm.

The specimens sent by Mr. Gowdey (no. 1290) were found on mulberry (*Morus* sp.), at Kyetume, Uganda (*Dr. R. Van Someren*, 28.xi.10).

Lecanium hesperidum (L.).

Abundant on the leaves, chiefly along the midrib, of the orange; Bakoba, German East Africa (*C. C. Gowdey*, no. 1327). No date given.

This is a common pest of the orange in many parts of the world.

Lecanium viride, Green. (The Green Scale Bug.)

Dried specimens of this insect are practically inseparable from *Lecanium hesperidum* (L.); but the morphological characters of these species differ in a marked degree. Mr. E. E. Green * gives a very interesting account of this pest. He says that "it has proved such a scourge in Ceylon, being practically responsible for the final abandonment of coffee cultivation over the greater part of the planting districts."

One of the most striking characters, as seen under a low power of the microscope, is the large ovate or rounded spots (derm cells), which are clearly distinct in well-stained preparations. In the African material these

* 'Coccidæ of Ceylon,' p. 200.

spots are arranged much more closely together than shown by Green in his excellent memoir; and it should be noted also that the "scattered arch of circular wax glands . . . . enclosing the genital orifice," observed by Green in his type, is not traceable in the females from Uganda.

The leaves upon which the specimens were sent were unnamed, but they appear to be referable to the guava; Entebbe, Uganda, 25.xi.10 (*C. C. Gowdey*, no. 1430).

The var. *africanum*, Newstead, has been recorded from the West Coast of Africa; but this, so far, is the only recorded habitat for the typical form in Africa.

Lecanium sp.

Almost covering the leaves of Citronella Grass (*Andropogon* sp.). All the examples are females, and quite 98 per cent. of them had been destroyed by a Chalcidid parasite. No examples of the latter were present in the envelopes in which the Coccids were packed, so that it is evident that the parasites had escaped before the hosts were collected.

Ceroplastes singularis, sp. n.

Test of adult female hemispherical; thin and very hard; texture fairly smooth: dorsum with a faintly indicated plate, almost circular in outline, with indications also of three lateral plates; colour dirty ochreous.

Length 3 mm.; width 2·5 mm.

Female, adult.—Hemispherical; cephalic lobe moderately produced; stigmatic clefts shallow; caudal process rudimentary; derm thin and transparent, after maceration in caustic potash. Antennæ (fig. 2) of six segments with four stout hairs of varying length on the 2nd segment, a very unusual character. Legs normal. Mentum monomerous, with several (?10) short stout spinose hairs. Marginal spines large: these are set closely together all round the margin; and on either side of this series are many slender spines and scattered spinnerets. Stigmatic spines, 15–20 in number, similar to those at the margin. Derm coarsely and faintly reticulated, each reticulation with a central pore.

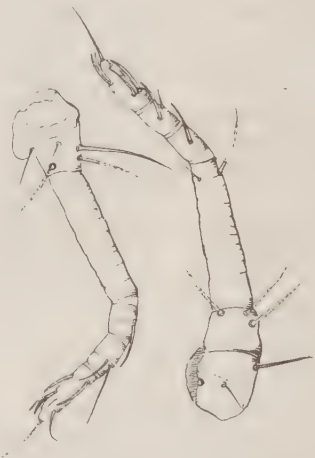


Fig. 2.—*Ceroplastes singularis*, Newst.; antennæ of adult female.

Test of young adult female hemispherical; thin and glass-like but opaque; two lateral plates darker, immediately below each of these a *very broad* band of pure white wax marking the stigmatic areas.

The example from which this diagnosis is drawn is about half the size of the old adult female test described above.

Test of the larva (fig. 3) formed of a more or less rounded mass of white flocculent matter.

Test or puparium of the male (fig. 4) ellipsoidal in outline ; with an elongate median patch or pad of densely felted white wax transversely divided in the centre in a large percentage of specimens ; lateral waxen appendages opaque white, forming a compact and contiguous series all round the margin,

Fig. 3.—*Ceroplastes singularis*, Newst. ; larvæ. ×2.

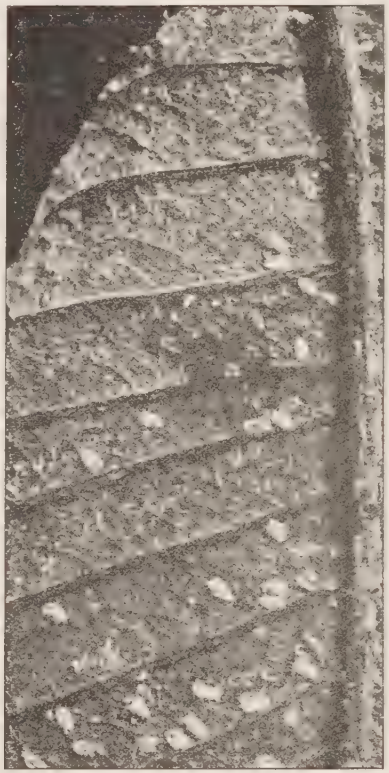


Fig. 4.—*Ceroplastes singularis*, Newst. ; male puparia. ×2.

usually carrying patches of the flocculent matter secreted by the larva ; beneath this external covering is a thin, opaque white, glassy layer of secretionary matter having a large central elongated raised area surrounded by a deep groove and concentric ridge from which the sides slope downwards to the margin. The whole surface of this glassy layer is strongly and evenly punctate ; and the anal lobes of the pronymph project beyond it relatively

for some considerable distance. The true character of the glassy portion can be seen only after carefully dissolving off the outer waxen layer with xylol.

Length 1·25–2·50 mm.

Male, second stage.—Ellipsoidal; margin with a series of rather widely separated, large spines, of which there are 16–17 on either side; besides these there is also one additional submarginal spine in each of the stigmatic areas. Antennæ of six segments, of which the third is about equal in length to the 4th, 5th and 6th together. Legs normal. Angles of posterior cleft each with two long hairs.

On guava (*Psidium guava*, Radd.); Entebbe, Uganda Protectorate, 22.xi.10 (*C. C. Gowdey*, no. 1275).

This species is remarkable for the very singular character of the male puparium, which in its external form bears a striking resemblance to small examples of *Dactylopius nipæ*, Mask.; so much so, that they were mistaken for examples of this or an allied species, before the microscopical preparations were made. The male puparium of the, hitherto, only other known species of *Ceroplastes* * is of the typical Lecaniid form, and without any flocculent or opaque waxy appendages † of any kind. It may be necessary at some future date to raise *C. singularis* to subgeneric rank, though in the light of our present knowledge, and in the absence of a larger series of the adult females, such a course would at the present moment be inadvisable.

Another remarkable feature regarding the male puparia is that they occurred in enormous numbers on the under surface of the leaves of the food-plant, presenting a very striking appearance. It is interesting to add also that a very large percentage were parasitized by a small Chalcidid insect, but unfortunately pupæ only were found. A few of the puparia also contained pupæ of the *Ceroplastes*, but these did not afford any morphological characters of note.

Chavannes ‡ has described a *Ceroplastes* from *Psidium* sp.; but, so far as one can gather, this species is distinguishable by the marked character of the waxen test or puparium of the female. The male or its puparium is not described.

A few examples of *Aspidiotus cyanophylli*, Sign., were found in association with *C. singularis*.

Ceroplastes ficus, sp. n.

Test of adult female more or less hemispherical, thin, semitransparent, hard and brittle, shaded with horn-coloured greys and browns; the large dorsal

* *Ceroplastes ceriferus*, Anderson, Newstead, Ind. Mus. Notes, iii. no. 5, p. 22.

† The male puparia of the *Ceroplastes*, no. 1326 (see p. 192), is of a similar character, but there is no flocculent matter present.

‡ *C. psidii*, Ann. Soc. Ent. France, (2) vi. p. 139 (1848).

area comparatively smooth, with distinct lines radiating from the central nucleus, the larger ones being widely separated and equidistant. Besides these there are also some faint concentric ones visible in some of the examples. Lateral plates narrowly rectangular, length much greater than width, outer angles produced and darker than the rest : caudal process triangular, with the angles rounded ; anal valves nude, minute, and only visible under a rather strong magnification.

Length 6–6·25 mm. ; width 5–5·25 mm.

Female adult (fig. 5, A) more or less hemispherical ; margin with three

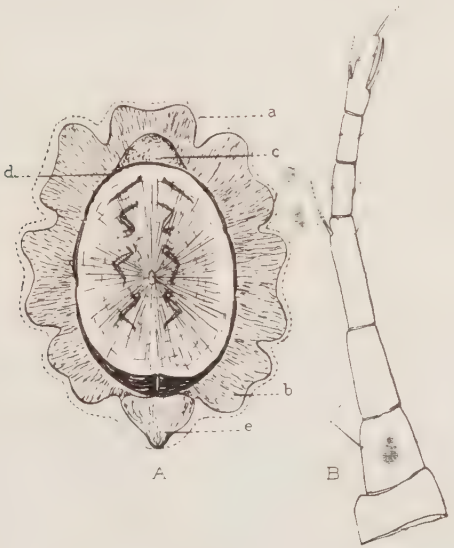


Fig. 5.—*Ceroplastes ficus*, Newst.

A. Outline of adult female as seen by transmitted light, in xylol: *a*, extent of waxen test; *b*, the chitinous lobate margin; *c*, the cephalic lobe; *d*, the true margin of the venter; *e*, the caudal process. B. Antenna of adult female.

bilateral and one cephalic, broad, flat and faintly bituberculate projections ; the tubercles widely separated and somewhat inconstant in size, some being faintly indicated, others very pronounced ; caudal process short, width at base slightly greater than the length, apex suddenly attenuated. Derm thin and transparent, and of a pale horn-colour ; tubercles and caudal process darker. Antennæ (fig. 5, B) of seven segments ; third and fourth equal in length and longest ; the last three segments with long slender spines. Stigmatic clefts very small and shallow ; spines small and conical, about 27 in number ; immediately within these is a large and very compact group of circular spinnerets numbering from 90–100 in all ; these organs are

however very difficult to trace and so far have not been observed in the posterior clefts, owing to the opacity of the chitin at the margin. Measurements very slightly less than those of the test.

The singular outline is one of the most striking characters of this insect (fig. 5). It may be readily seen by placing examples in xylol, which quickly renders the very thin waxen test sufficiently transparent but does not, even after long immersion, dissolve it. The long fourth segment of the antennæ and also the compact group of spinnerets are unusual, and may assist in the determination of the species.

On Bark-Cloth (*Ficus* sp.) ; Bukoba, German East Africa, 4.iv.10 (*C. C. Gowdey*, no. 1328).

Ceroplastes ? sp. n.

Test of young female formed of rather hard, dirty, creamy white wax ; sides rounded, lateral plates obscure, but their positions are indicated by a small central depression, in many instances ; posterior half of the dorsum with a prominent hump suddenly truncate behind, in the centre of which is placed the anal process.

Length 3–3·5 mm. ; height 2·75–3 mm.

Female, young adult.—Elongate, widened posteriorly. Anal process rudimentary, surrounded by a disc-like patch of dark chitin. Antennæ of six segments, the third much the longest. Stigmatic clefts very shallow ; spines relatively large and conical ; they are continuous along the margin both between and beyond the stigmatic clefts, but do not extend to either the cephalic or posterior margin.

Length 2·5–3 mm.

This insect is in all probability an hitherto undescribed one ; but as the examples before me are immature, I do not feel justified in erecting a new name for it ; the wax, though presenting a hard exterior, is readily soluble in xylol, and differs in this respect from *Ceroplastes ficus*. Taking this fact into consideration, and the difference in the character of the antennæ, I have come to the conclusion that the specimens are not immature examples of *C. ficus*, though they were taken from the same kind of food-plant and at the same date. All the examples were parasitized ; and it is just possible therefore that the parasite may have caused some alteration in the form of the test, though this is very doubtful.

On Bark-Cloth (*Ficus* sp.) ; Bukoba, German East Africa, 4.iv.10 (*C. C. Gowdey*, no. 1329).

Ceroplastes ? sp. n.

Female, second larval stage.—Broadly ovate or almost subcircular, with three bilateral, white, waxen appendages, widely separated ; there are also three cephalic and three posterior processes, but these are minute and placed

closely together; median dorsal plate narrow and elongate. Integument between the waxen plates of various shades of horn-coloured brown, in the dried examples.

Male puparium elongate, with 13–14 white marginal appendages, the three anterior and the three posterior ones being much the smallest; median dorsal plate narrow and more or less irregularly divided transversely. These plates are attached to a glass-like layer which, when denuded of wax, is of the typical Lecaniid form.

Length 1·25 mm.

The striking similarity which these puparia bear to those of the second larval stage in the female of other known species, possibly accounts for the fact that they have hitherto been overlooked by students of this group of insects.

Judging by the morphological characters of the young larval females, I am of opinion that the male puparia are conspecific with the preceding species.

On Bark-Cloth (*Ficus* sp.); Bukoba, German East Africa, 4.iv.10 (*C. C. Gowdey*, no. 1326).

Fig. 6.—*Ceroplastes quadrilineatus*, Newst.; adult females (tests). ×2.

Ceroplastes quadrilineatus, sp. n.

Test of adult female (fig. 6).—Dorsum with a pair of large, divergent, pyriform bodies, the narrowed portions of which meet together immediately over the anal orifice; these very prominent swellings are of a dull crimson colour with distinct and well defined, narrow, transverse, blackish bands; under a low magnification the banding has the appearance of striæ, so that

these very prominent portions of the test bear a striking resemblance to a pair of miniature shells, of the fossil genus *Gryphæa*; sides bulging and somewhat irregular in outline, colour sooty-crimson; stigmatic bands pure white, narrow, extending right across the broad bulging portion of the test, forming four conspicuous white lines (two on either side) against the dark portion of the wax. The wax immediately beneath the surface is white with a faint pinkish tinge; it contains a large percentage of water and is soft and readily injured by pressure.

Length 6 mm.; width 6 mm.; depth 5–7 mm.

Adult female more or less hemispherical; sides bulging over the margin; cephalic lobe strongly defined; margin deeply incised at the stigmatic areas; caudal process rudimentary, appearing as a minute tubercular swelling, surrounding which is a very large circular area of piceous chitin; the rest of the integument dull ochreous in colour, but shining and coarsely wrinkled. Antennæ (fig. 7) of six segments, the third much the longest, equaling the length of the last three segments together; there is a long, slender, lateral spine on each of the fourth and fifth segments; and three similar spines also on the terminal segment, one subapical and two towards the proximal end of the segment. Parastigmatic glands widely separated, and forming a broad band; in structure they are simple and resemble the circumgenital glands in the Diaspinæ. Stigmatic spines very short and obconical; between these are a few (2–5) small spines. Ventral derm studded rather sparsely with spinnerets and minute spines, the former (fig. 7, *a*) have a distinct central septum which gives these organs in certain lights a figure of 8 shape.

Fig. 7.—*Ceroplastes quadrilineatus*, Newst.; antenna of female. *a*, spinneret; *b*, spine.

Length 6 mm.; width 5 mm.

This is a very singular species, distinguishable chiefly by the curiously shaped test, which together with the rather singular coloration and the four conspicuous white stigmatic bands will serve at once to distinguish it from any of its allies. When crowded together so that the waxy tests become agglomerated, the insects, collectively, very closely resemble a colony of lac insects (*Tachardia lacca*), though the surface of the secretionary matter in the *Ceroplastes* presents a more uneven surface than that of the *Tachardia*.

On *Anona muricata*; Kyetume, near Kampala, Uganda, 24.xi.10 (*C. C. Gowdey*, no. 467). Also on Bark-Cloth (*Ficus* sp.); Ndege, Uganda, 22.iv.10 (*C. C. Gowdey*, no. 397).

The larva of a small Lepidopterous insect had destroyed a large proportion of the females and their tests, and had formed their tunnels and tough silken cocoons amongst the cereous mass. No trace of either larvæ or pupæ was found.

Ceroplastes sp.

Many examples of the fixed larval stage of a species of *Ceroplastes*, resembling those of *C. floridensis*, have been received, thickly scattered over the upper surface of the leaves of the Guava. On the under surface of the same leaves were examples of *Aspidiotus cydoniæ*, Comstock (*C. C. Gowdey*, no. 1274).

Ceroplastes ?ceriferus, Anderson.

These are all immature females, the tests of which are badly damaged through careless packing. The young females when denuded of wax do not, however, present the well marked lateral tubercles so characteristic of this species in this and also the adult stage. It may be necessary, therefore, to give the Uganda forms specific rank : but the character herein noted may not be constant. With so few examples before me, this matter must be left until a more extended series is procurable for study (*C. C. Gowdey*, no. 467).

Stictococcus dimorphus, Newstead.

A large series of this species was sent, but these also were destroyed by mould : so that no further details are available regarding the morphology of this interesting insect.

Dactylopius ? sp. n.

The material is insufficient for diagnostic purposes; but all the visible morphological characters point to this insect being an hitherto undescribed species.

On *Harogana madagascariensis*; Entebbe, 7.iv.10 (*C. C. Gowdey*, no. 1433).

Chionaspis dentilobis, sp. n.

Female puparium white, *very highly convex*, sometimes strongly gibbose in front, and generally contorted by overcrowding; but many examples are more or less mytiliform. Pellicles orange-red.

Length 2·75–3 mm.

Puparium of male straw-coloured or pale ochreous, anal portion paler, median keel more or less clearly defined. Pellicle bright orange.

Length 1·25 mm.

Female, adult.—Generally markedly attenuated or narrowed in front. Pygidium broadly rounded or semi-circular ; derm as soft and thin as that

of the rest of the body, with two broad bands of large dorsal pores corresponding to those on the free abdominal segments; anal orifice opposite the distal ends of the dorsal pores; between the former and the margin are five linear and two oval thickenings of the body-wall. Circumgenital glands absent. Margin of pygidium (fig. 8 *a*) with three pairs of lobes; median pair smallest and widely separated, edge faintly dentate near the centre; second pair bilobed, the inner lobule much the largest, *with a strong tooth-like projection* on the inner lateral margin, outer lobule somewhat angular in shape and irregularly and faintly dentate; third pair of lobes trilobed, the median lobule the largest, lateral lobules distinctly dentate. Squamæ long, stout, and simple; there is one between the median and second pair of lobes, and a pair (one dorsal, the other ventral) immediately anterior to the

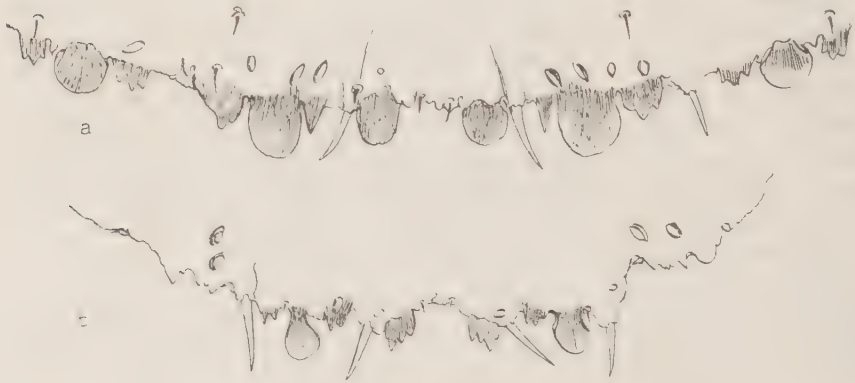


Fig. 8.—*Chionaspis dentilobis*, Newst.
a. Margin of pygidium of adult female.
b. Margin of pygidium of second-stage female.

second pair of lobes. Spines minute. Rudimentary antennæ with 3–4 strong spines, one of which is much stouter than the others.

Length 2–2·25 mm.

On the slender branches of an unknown shrub; Botanical Gardens, Entebbe, Uganda Protectorate, 18.xi.10 (*C. C. Gowdey*, no. 1270).

The females may be readily distinguished by the curious form of the pygidial lobes. Owing to the non-chitinised character, great difficulty has been experienced in getting satisfactory preparations for microscopical examination. With the younger forms this character is not present. The pygidial fringe of this stage is shown in the accompanying figure and may assist in the future identification of this insect (fig. 8 *b*).

Chionaspis substriata, sp. n.

Puparium of female satiny-white ; transversely striate, the striæ equidistant and well defined ; sides sub-parallel behind the pellicles ; highly convex in the mid region, posterior margin flattened and generally produced. Pellicles yellow ; the posterior margin of the 2nd generally nude and sometimes tinged with pale orange-yellow.

Length 1·50–2 mm.

Female, adult.—Cephalic region much narrowed ; pygidium broadly rounded ; *derm soft and as flexible as that of the rest of the body*, line of demarcation between free abdominal segments not clearly defined. *Proboscis placed quite close to the anterior margin.* Margin of pygidium (fig. 9) with three pairs of *very short* serrated lobes ; the second pair duplex ; all the lobes are more or less rudimentary, and, owing to the flaccid nature of the body-wall which has a constant tendency to fold or project, the lobes in a large percentage of specimens are rendered either perfectly obsolete

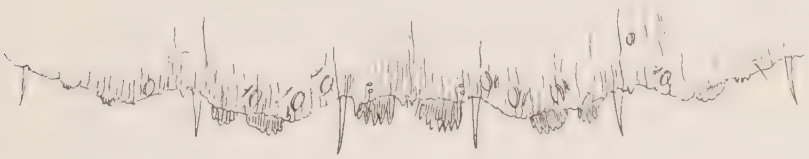


Fig. 9.—*Chionaspis substriata*, Newst. ; margin of pygidium of adu't female.

or appear only as minute and faintly serrated projections. Squamæ large and spine-like ; there are usually 3–4 on either side of the median lobes. Dorsal glands, with *very short subcutaneous tubes*, occur all along the margin, and there are a few similar ones indicating the articulations of the segments. *Circumgenital glands absent.*

Puparium of male * satiny white, with the median keel distinct on the posterior half only ; pellicle yellow.

On palms ; Botanic Gardens, Entebbe, Uganda Protectorate, 29.iii.09 (*C. C. Gowdey*, no. 304).

The distinguishing features of this well marked species are the serrated lobes and the forward position of the proboscis. In the sculpturing of the female puparium this species very closely resembles *Chionaspis striata* ; but the female of the latter species has grouped circumgenital glands, the puparium is thinner and more glossy, and the lobes are not serrated.

* The male puparia are for the most part incomplete, and in this condition very easily pass for those of *Mytilaspis*.

? Diaspis chionaspiformis, Green, MS., sp. n.

Female puparium creamy white : form like that of a typical *Chionaspis*. Pellicles dusky reddish yellow.

Length averaging 1·75 mm.

Male puparium apparently non-carinated, white ; forming dense masses with innumerable threads of white flocculent secretion between them, somewhat like the colonies of the male puparia of *Diaspis boisduvalii*, and they are so arranged that they project almost at right angles to the branch.

Female, adult, with the cephalo-thoracic region attenuated. Rudimentary antennæ with two long, curved, spines. Anterior stigmata with 3–4 parastigmatic glands. Circumgenital glands in five groups. Formula of two examples :—

6		8	
23	25	25	28
30	28	36	29

Pygidium (fig. 10) well defined. Median lobes bilobed and united, the lobules nearly equal in size ; 2nd and 3rd pairs angular and rudimentary.

Fig. 10.—? *Diaspis chionaspiformis,* Green ; margin of pygidium of adult female.

Squamæ spinose, 3–4 on either side of the median lobes. Median pair of spines stouter than those on other parts of the pygidium. Anal orifice placed near the centre of the circumgenital glands. Dorsal pores numerous on all the segments, especially so in the three thoracic ones.

On an unknown plant ; Botanical Gardens, Entebbe, Uganda Protectorate, 18.xi.10 (*C. C. Gowdey*, no. 1271).

Easily distinguished by the united median lobes and the *Chionaspis*-like form of the female puparium. It is an aberrant form and may subsequently be placed in a subgenus of *Chionaspis*.

Aspidiotus cyanophylli, Signoret.

Abundant on palms and sparingly on Antignon ; Uganda, 24 & 25.xi.10 (*C. C. Gowdey*, no. xix.).

This insect does not appear to have been recorded previously from Africa,

though it is widely distributed elsewhere. It is a very general feeder, and among its numerous food-plants may be mentioned tea and cinchona ; it is also a pest to palms under cultivation in England.

Aspidiotus cydoniæ, Comstock.

The examples received occur sparingly along the midrib and veins of the leaves of the Guava, in company with immature females of a species of *Ceroplastes*.

Entebbe, Uganda, 25.xi.10 (*C. C. Gowdey*, no. 1274).

Ischnaspis filiformis, Douglas. (The Black-thread Scale.)

The very long and narrow puparia of this insect look like little bits of black thread attached to the midrib or veins of the leaf of the food-plant. It has not hitherto been recorded from Uganda, though it has occurred as a serious pest to coffee elsewhere in Central Africa.

On palms ; Entebbe, Uganda, 25.xi.10 (*C. C. Gowdey*, no. 1287).

APHIDIDÆ.

Cerataphis lataniæ, Boisduval.

This curious plant-louse is known generally to horticulturists as the "Fringed Scale," otherwise as the "Horned Aphis." It bears a remarkable resemblance to a Coccid, and is often mistaken as such. The late Professor Westwood also mistook it for a Coccid and named it* *Asterolecanium orchidearum* ; though Buckton† makes no reference to the fact in his monograph.

It does not appear to have been hitherto recorded from Africa ; but it is a common pest in this country on plants cultivated under glass, affecting chiefly palms and orchids.

* 'Gardeners' Chronicle,' December 20th, 1879.

† Monograph Brit. Aphidæ, iv. p. 198.

June 1910.

REMARKS ON COCCIDÆ FROM UGANDA.

By E. ERNEST GREEN,
Government Entomologist, Peradeniya, Ceylon.

In Prof. Newstead's paper "On Scale Insects from the Uganda Protectorate" (Bull. Entom. Res. Vol. I. pt. 1) is a description and figure of the male larva of *Stictococcus dimorphus*. This remarkable larva is said to have no mouth parts. It is also unique in differing completely in form and structure from that of the female larva of the same species. Its anal aperture is not only in a different position, but of a different character—having a setiferous ring similar to that of the Dactylopiinæ. *Stictococcus* is (rightly or wrongly) placed in the subfamily Lecaniinæ.

This strongly-marked sexual dimorphism in a larval Coccid is of itself unprecedented; but the total absence of buccal organs is astounding. One naturally asks—how does this insect obtain the nourishment that must be necessary for further growth and the completion of its development? I can conceive of only one possible explanation of such a condition, and that a somewhat improbable one:—namely that the species is parthenogenetic and that, in addition to functionally fertile female progeny, a certain number of abortive male larvæ are produced.

Prof. Newstead does not state whether both of these larval forms were taken from the marsupium of a single female,* nor whether any later stages of the male insect have been observed.

With regard to Prof. Newstead's determination of *Aspidiotus lataniæ*, Sign., in this same paper, I think that he must have overlooked the facts recorded in the Ent. Mo. Mag. xxxv. p. 181 (1899), in which, from examination of Signoret's actual type material (kindly lent by the Vienna Museum), I showed that the species so closely resembling *A. destructor* had been wrongly determined as *lataniæ*, and that the true *lataniæ* was apparently identical with *A. cydoniæ* of Comstock. The insect that I had—in the first part of my "Coccidæ of Ceylon"—confounded with *lataniæ* reverts to its earlier name of *transparens*, Green (see Journ. Bombay Nat. Hist. Soc. vol. xiii. No. 1, p. 69, 1899). Whether *cydoniæ* is or is not acknowledged to be synonymous with *lataniæ* of Signoret, the species here recorded by Prof. Newstead as *lataniæ* should stand as *transparens*, Green.

* [Larvæ of *both sexes* were taken from the marsupium of a single female.—R. N.]

It would be impossible to confuse either the dried puparia or the adult female insects of typical *latanicæ* with those of *destructor*, but they might easily be mistaken for those of *camelliæ*, Sign. In fact, the insects of these two species can be separated only by the presence or absence of circumgenital glands, which occur in *latanicæ* but are wanting in *camelliæ*. All the other characters of the pygidia of the two species are practically identical.

Peradeniya, Ceylon,
15 June, 1910.

PRÉCIS OF REPORTS SUBMITTED BY DISTRICT RESIDENTS CONCERNING TSETSE-FLY AND CATTLE DISEASE IN THE NYASALAND PROTECTORATE.

Presented to the Legislative Council, by command of His Excellency the Governor, November, 1909.

(With Map.)

Memorandum on the Reports.

It is clear from the reports sent in by District Residents that they have done their best to ascertain and lay down, as far as they are able, all facts bearing on the distribution of tsetse-fly in Nyasaland. It has to be borne in mind, however, that all statements on such a subject as this, except by experts, require to be received with caution. Some Residents have only been in their present Districts for a comparatively short period, and their information is largely obtained, not from direct personal observation, but as the result of inquiries made from Europeans and Natives. Native information as regards tsetse-fly may be looked upon as entirely valueless: the proportion of Nyasaland Natives who know or can describe tsetse-fly is very small.

I have noted inaccuracies in several reports.

A number of years ago I roughly coloured on the old map of this Protectorate, compiled by Sir Harry Johnston, the Districts which I looked upon as being "Tsetse-Fly infested." From all the information that has been gathered I have no reason to alter the limits of these areas, which I think have remained practically the same as they were many years ago.

The increase of stock owned by Europeans and the general attention which has been called during the last two or three years to the tsetse-fly question has resulted in the discovery of fly by many people in localities where they, personally, had not known of its existence before; and they have been inclined to fancy that it has recently invaded such localities.

Since the pacification of the Protectorate and the cessation of Native Wars, large numbers of Natives, especially Atonga, Achewa, and other former slave tribes, have acquired cattle, and in many instances their cattle have died from tsetse-fly disease, owing to their being kept in country where fly exists. This also has drawn the attention of settlers and missionaries more to the question than formerly.

My opinion, based on a long residence in this country and a general acquaintance with every part of it, is that there are certain limits of country which may be called "Tsetse-Fly Districts." What are the precise conditions which are necessary for the existence of the fly is impossible at present to say : but I think that beyond the limits of these Districts they do not go. Some years they may be found in various localities within these Districts, whereas in other years they may be found in other portions. Their presence also varies according to the season of the year.

(Signed) ALFRED SHARPE,
Governor.

Cattle Disease in the Nyasaland Protectorate.

The following Motion was passed at the May Session, 1909, of the Legislative Council :—

"That this Council requests His Excellency to call for reports from the Residents of each District as to the condition of cattle disease, existence of tsetse-fly and reported spread of the fly to new districts ; and that the said reports, together with such other information as may be available, be collated and submitted at the next Session of the Council."

His Excellency the Governor issued directions that Residents of Districts should be instructed to prepare and submit Reports on the subject, such Reports to embrace the following heads :—

(*a*) Cattle diseases amongst European and Native stock in each District ; and (*b*) the existence and distribution of tsetse-fly in relation thereto ; and (1) cattle statistics for the past five years, with mortality, &c. ; (2) actual tsetse-fly area ; (3) increase in tsetse-fly area—if any ; (4) a Sketch Map to illustrate (2) and (3).

Residents were instructed that the Reports should be comprehensive and deal clearly and succinctly with the whole question of cattle mortality, more especially in relation to the existing tsetse-fly areas and the extension or diminution of such areas during the past five years.

Carefully compiled reports were accordingly rendered by the Residents in charge of Districts, of which the following is a Précis. European stock-owners were communicated with and their views are embodied in the reports

NYASALAND PROTECTORATE

I. *Stock.*

District.	European Stock.		Native Stock.	
	1904/5.	1909/10.	1904/5.	1909/10.
1. Lower Shire	21	163	—	—
2. Ruo	?	100	112	113
3. West Shire	—	156	149	204
4. Blantyre	—	4,805	12	163
5. Mlanje	?	627	—	17
6. Zomba	—	1,161	54	a few
7. Upper Shire	—	803	518	942
8. South Nyasa	?	99	97	507
9. Central Angoniland	812	1,923	628	1,012
10. Marimba	?	262	462	1,015
11. West Nyasa	—	67	80	2,399
12. Mombera	?	205	8,000	23,000
13. North Nyasa	650	486	11,208	15,462
	6,577*	10,857	21,320	44,834

II. *Increase or Decrease of Tsetse-Fly Area.*

1. Lower Shire.

No tsetse-fly yet observed in any portion of the district, either near the River or in the Hills.

2. Ruo.

The existence of tsetse in this district is open to argument †. Whereas

* The figures for 1904/5 are approximate; details for each District not now available from Statistics; only the total was shown in the Blue Book and the returns destroyed; the increased figures for 1909/10 should not therefore be necessarily put down to natural increase entirely, but rather to a more accurate knowledge of the numbers of European and Native Stock.

† [Dr. J. B. Davey has recorded (Bull. Ent. Res. pt. 2, p. 143) that he found *G. fusca* numerous at Masinjiri's and Kaporo on all of several visits. This clearly indicates the risk of relying upon negative evidence with regard to this species from observers who have no special knowledge of its peculiar habits.—Ed.]

one specimen of *Glossina fusca* was found at Masinjiri in 1906, the Government Medical Officer, Resident, and residents have not been able to find another specimen in any part of the district. If *Glossina* exists at all it must be in small numbers. Buffalo sometimes feed close to domestic cattle without detriment to the latter.

3. **West Shire.**

No tsetse-fly found during last five years.

4. **Blantyre.**

The fly-belt in this district is well defined and has been well known for some years. It extends along the river from below Mpimbi to near the mouth of the Likabula River. It is reported by cattle-owners that the belt has extended during the past five years up the Lirangwe River and Matope Road, towards Blantyre, but to what distance is not stated nor proof afforded.

Another new fly-area reported is south of Mpemba Hill, but it is not known whether in this case the fly extends to the Shire River or not. Fly found ten years ago round Sakata Hill, near the Tuchila River, have not since been observed.

5. **Mlanje.**

Residents of from 5 to 20 years' standing have failed to observe tsetse in this district. Dr. P. Wykesmith is the only observer who has encountered *G. morsitans,* which he found a few years ago in the following localities :—

(1) On the Sombani River within the sphere of Chief Mtemanyama ; (2) near the Tuchila River at the crossing of the the Blantyre–Fort Anderson Road ; (3) north-west of the Thornwood Estate at the back of Mlanje Mountain.

The Residents have not encountered tsetse during their travelling, although *Stomoxys* was met with. There are no statistics to show whether the fly-area has extended : such evidence as exists points to the contrary.

6. **Zomba.**

A fly-belt on the Shire between Matope and Mpimbi has been known to exist for some years, which, apparently, has not spread far eastwards. North of the Domasi, fly have also been known for many years.

Extensive fly-belts are reported to exist from the Namadzi River on the Mlanje Road as far as to the Likangala River and Mtonya Hill, 4 miles east of Zomba ; also on Lufani Stream, a tributary of the Domasi River. No fly, however, have been reported on the Zomba–Blantyre Road, which is continually used for cattle transport. Cattle have had to be moved during the past five years from the Likangala, Newington and Chikala districts, where they formerly flourished, on account of the encroachment of tsetse.

Fly are also found scattered about in the country north-east of Chikala, though not in well-defined belts.

One land-owner considers that the fly-area is increasing, due to tsetse following larger game which have become tame through preservation and now frequent inhabited country. This statement, however, does not coincide with the fact that game in the Zomba district has decreased enormously during the past 10 years, due to continual hunting by Europeans and Natives, and also to restricted areas for feeding and sanctum owing to the extension of the native population eastward.

Another cattle-owner attributes the spread of fly to the increased numbers of goats and sheep which now pass through the country on their way to the Blantyre market.

Both assumptions lack proof. The only definite fact obtainable is that tsetse change their habitat, but there is no proof as to the cause.

7. Upper Shire.

The Resident states that "prior to the year 1904 *G. morsitans* was but occasionally found in this District. In 1904/5 this fly was noticed in large numbers at Liwonde and in the surrounding country and generally along the Shire River. It seemed to have suddenly spread throughout the River."

This statement is incorrect, for as far back as 1887 the Upper Shire Valley on both sides has been full of tsetse, extending north almost as far as Cowa. In the country near the Rivers Kapeni, Rivi-Rivi, Liwawasi, Nkasi and Chimwalire, tsetse is found ; also on both sides of the Shire from Mvera to Matope, and on the Likwenu to the south-east.

Cattle-owners report that the fly has spread at Dzunje, near the Mission Station at Chiole, on the Livilezi to the north of Ncheu, and at Malosa at the south-east extremity of the district,—areas which were formerly clear of this pest,—necessitating the removal of their herds.

8. South Nyasa.

Fly exists, or is suspected to exist, practically throughout this district except : (1) in that portion lying between the triangle made by the Fort Johnston–Mangoche Road, the Portuguese boundary and the Lake shore : here no fly has ever been seen ; (2) a small area in the hills to the north-east of Mt. Pirolongwe : (3) on the east side of Lake Malombe and extending to the foot of the Mangoche Hills and beyond to the Mandimba stream.

9. Central Angoniland.

The Resident reports that "In the year 1904 tsetse were confined to a small patch about five miles from the Lake shore and south-west of Rifu, and to the low foot-hills south of the Lintipe River to Kachindamoto. From 1904 up to the present date tsetse-fly have steadily spread up towards the

hills and north from Domira Bay, so that at the present time the whole of the country below the 2500 ft. level to the Lake shore (with the exception of a few miles of plain and timberless country here and there) may be said to be infested. South of the Lintipe, the spread of tsetse has not been so noticeable, as the original belts were not so clearly defined, the country being very broken *and not extensively visited by Europeans.* The tendency at present is for the tsetse to spread closer to the Lake, whereas a few years ago they were seldom met with within a distance of five miles or so back from the Lake."

The alleged "spread" of the fly is possibly explained by the fact that new fly-areas have now been found, hitherto not discovered. The rest of the district other than that mentioned can be described as free from fly.

10. **Marimba.**

Kota-Kota division.—From the Dwangwa River Boundary to the Chirua River Boundary, extending inland to the Hills, tsetse is prevalent. The tendency of the fly is to spread from the Lake level up along the river banks: it has advanced along the River Bua to the foot of the Mdonda Pass; also along the Kaombe River to the villages of Ngoma and Mbobo, approaching the Ngara boundary. A similar tendency has been observed along the Dwangwa, Chirua and other rivers.

Ngara division.—With the exception of the Upper Lingadzi and Mpongala Rivers near the eastern boundary, where fly were discovered in 1907, no tsetse exist in this division. It is suspected that the fly is spreading east from the Rukuzizi [? Lukuzi] River in North Eastern Rhodesia.

11. **West Nyasa.**

The only known fly-area is a strip along the Lake shore from the Dwangwa River north to Kuwirwe Mountain. This extends from a short distance back from the shore to well on to the foot-hills. Seven years ago a European drove a large herd of cattle up through this area to Kuwirwe without seeing a fly or losing one head. This may point to the possibility or not of the fly-area being of recent date. On the other hand, fly was found 20 years ago in the Limpasa Valley, and none have been observed recently. The population is small and owns practically no cattle, so the absence or otherwise of fly throughout this district cannot yet be proved.

12. **Mombera.**

No tsetse-fly have yet been found in this district.

13. **North Nyasa.**

G. morsitans is found around the Vwaza Marsh in the south-west corner of the district and along the Hewi River a short way; and *G. fusca* at Kaporo, in a belt of forest along the Lake shore and for a short distance

inland, from the River Lufire to a little south of the River Songwe. Between 1893 and 1895, it was reported that flies were found at the back of Deep Bay on the marshes and dambos known as the Hara Plain: none can be found to-day; also that tsetse existed in large numbers in the Henga Valley about Mt. Jakwa and on the Runyina River which flows into the Rukuru some 10 miles west of Jakwa. In spite of careful search by three Government Medical Officers, no flies have been found in recent years.

Observations on Reports of Tsetse Areas.

It is probable that the large increase in cattle, and ox-transport, has drawn greater attention to the subject of tsetse-fly: consequently, areas hitherto unnoticed are now described as fly-belts due to the "spread of tsetse," whereas such areas may have been in existence for many years.

It is noticeable also that in the Mombera district, a cattle country, there is no tsetse-fly; and in the North Nyasa district, also a cattle and game country, the tsetse areas are minute.

In the West and Lower Shire districts no tsetse have been found, which is remarkable in view of the extensive belt which exists along the river valley from Mvera to Matope; it would have been reasonable therefore to anticipate that the fly would have spread along the Valley southwards to Port Herald and below.

III. *Outbreaks of Cattle Disease during Period* 1905–1909.

1. **Lower Shire.**

(a) *Trypanosomiasis.* No deaths.

(b) *Other causes.* Seven calves from inattention.

2. **Ruo.**

(a) *Trypanosomiasis.* Two bulls at Masinjiri died in 1905; deaths proved to be through tsetse-fly. Makwira lost some cattle a few years ago, supposed to be through the same cause, though not proved.

(b) *Other causes.* District is healthy one for cattle, and no epidemics have appeared amongst Native or European cattle for some years.

3. **West Shire.**

(a) *Trypanosomiasis.* No deaths.

(b) *Other causes.* No epidemics. Cattle healthy. Mortality chiefly by accident, wild animals, old age, etc.

4. **Blantyre.**

(a) *Trypanosomiasis.* Sixty-four deaths reported since 1904: of these 56 occurred in 1906, amongst cattle owned by the African Lakes Corporation when their cattle were grazing in the neighbourhood of Lirangwe Stream;

7 in 1908, amongst cattle conveyed from Fort Johnston to Liwonde by barge at night and thence to Blantyre *via* Zomba ; 1 other in 1908, the animal being reported to have been bitten to the south of Mpemba Hill.

(b) *Other causes.* No epidemics during period with exception of eye disease: no record of deaths from this. From *Stomoxys*, other biting flies or tick disease, no record of any deaths having occurred ; 139 deaths through accident or natural causes, of which 50 are stated to have died from hard work and scarcity of food, being trek oxen ; 30 deaths from eating poisonous herbs ; 8 due to attacks by wild beasts, some few from snake bite, others from pneumonia or old age.

5. **Mlanje.**

(a) *Trypanosomiasis.* No deaths or cases.

(b) *Other causes.* Healthy district. No epidemics. Mortality through old age and accident.

6. **Zomba.**

(a) *Trypanosomiasis.* Fifty-six head at Zomba, some of which were proved to be due to tsetse, others suspected.

(b) *Other causes.* 134 through natural causes; 56 were transport cattle which died in 1909, of which 26 were full grown in 1900 and 10 bought since then were old. No tick disease ; immunity due to bush fires; no deaths from *Stomoxys* or epidemics.

7. **Upper Shire.**

(a) *Trypanosomiasis.* Heavy mortality amongst Native cattle, estimated at 150 in 1906/7, 100 in 1908/9, and 23 in 1909/10. European cattle, 23 in 1904, 9 in 1905/6, 69 in 1906/7, 16 in 1907/8, 19 in 1908/9. These epidemics occurred north of the River. Two separate investigations were made by Government Medical Officers, who pronounced the disease to be trypanosomiasis. Herds were removed to the plateaux and now immune from attacks. Some Native owners were also induced to remove their cattle.

Deaths from same cause also reported at Malosa in 1907, and 24 at Dzunje in 1905/6, which are not included in above as the owner reported to the Zomba Resident.

(b) *Other causes.* Considerable sickness and unusual mortality observed in 1905/6 and 1906/7, said to be due to bowel complaint, but suspected to be trypanosomiasis, as similar outbreaks in succeeding years were so diagnosed. Other diseases unknown.

8. **South Nyasa.**

(a) *Trypanosomiasis.*

West side.—In 1905 a few deaths occurred amongst Native cattle in the

neighbourhood of the Livilezi and Bwanji Rivers, and on examination the cause was declared to be tsetse-fly. From 1906 to 1909, 75 deaths have occurred which are attributed to this cause. The result is that only 15 head remain on the west side of the district.

East side.—No deaths from fly. European cattle : 350 head distributed, which have done exceedingly well. In June 1909, trypanosomiasis broke out at Fort Johnston, resulting in 3 deaths.

(b) *Other causes.* No remarks.

9. **Central Angoniland.**

(a) *Trypanosomiasis.* No mortality except through tsetse-fly. Mortality not great. When tsetse observed cattle are immediately moved. No mortality amongst European cattle as none in areas.

Native-owned Cattle.

Year.	Number.	Mortality.
1904.....	602	6
1905.....	628	28
1906.....	580	24
1907.....	826	26
1908.....	860	60

(b) *Other causes.* Wild beasts, accident or natural causes. No epidemics.

10. **Marimba.**

Kota-Kota division.

(a) *Trypanosomiasis.* No cattle in fly-areas, therefore no deaths.

(b) *Other causes.* Twenty-one deaths between October 1907 and May 1908. Cause unknown. No recrudescence of disease. 15 died at Nchisi in 1908 ; no fly found although searched for.

Ngara division.

(a) *Trypanosomiasis.* Two deaths attributed to this cause amongst Native cattle. No deaths amongst European owned cattle from tsetse-fly.

(b) *Other causes.* Native cattle increased from 462 to 945 in five years. Cattle healthy. Deaths due to old age or wild beasts. 10 per cent. of calves born die from neglect.

11. **West Nyasa.**

(a) *Trypanosomiasis.* All deaths due to this cause as far as records can show. Cattle only kept for barter, exchange and gifts as "Chumaro" on marriage.

(b) *Other causes.* Cattle are generally unhealthy. Atonga recently taken to cattle rearing and lack of care tells probably more than climatic causes.

12. **Mombera.**

(a) *Trypanosomiasis.* No deaths.

(b) *Other causes.* Disease appeared in 1902. In 1907 an epidemic broke out resulting in 550 deaths, equal to 2½ per cent. In January, 1908, a similar outbreak with 250 deaths, or 1 to 1¼ per cent. Disease disappeared in April. From blood-slides, disease first diagnosed as East Coast Fever. From subsequent examinations this is refuted. Veterinary expert now investigating.

13. **North Nyasa.**

(a) *Trypanosomiasis.* Not known.

(b) *Other causes.* Outbreaks similar to that experienced in Mombera district, though younger cattle about 12 months old generally attacked. In 1907 an outbreak was diagnosed as Catarrh. It recurred in 1908 and resulted in 75 per cent. of the total deaths, which were about 1 per cent. Dr. Davey made exhaustive investigations, but failed to discover much except that in the stomachs of most calves blood-sucking worms* were found, and in others ulcerated intestines. He considers the disease is more likely to be due to a bacillus than a parasite.

Total mortality amongst 11,208 head estimated at ½ to 1 per cent.

(Signed) JOHN B. KEEBLE,
Acting Chief Assistant Secretary.

Zomba, 7th October, 1909.

* [*Haemonchus contortus*—which might well account for some of the deaths.—Ed.]

MOSQUITO LARVÆ AND THEIR NATURAL ENEMIES.

In his Annual Report for one of the districts of the island of Saint Lucia, West Indies, Dr. Lucius Nicholls enters somewhat fully into the above subject. He points out that "it is useless to urge Governments with limited funds to undertake enormous drainage schemes, or to obtain costly apparatus to fill up marshes that are below river or sea level; other and far less costly methods must be found." While it is admitted that for the wholesale extermination of mosquitos in the vicinity of towns of some size, drainage is doubtless the most suitable and effective method, yet it is urged that in the case of villages and sparsely populated agricultural areas a great deal might be done in the same direction by breeding and distributing the more important natural enemies of the larvæ of the Anophelinæ.

Dr. Nicholls' observations have so far been principally restricted to the two species of Anophelines which occur in his district, namely, *Cellia argyrotarsis* and *C. albipes*; and, as he is careful to point out, his deductions may not apply to other Anophelines, even of the same genus, in other parts of the world. Yet even so, his notes may be of value as indicating the kind of observations and experiments which are likely to be of practical utility, and it may be well therefore to quote them at some length.

"The following definite statements can be made from notes taken in an extended search for the larvæ of these mosquitos [the two species of *Cellia* mentioned above]:—

(1.) That their breeding places contain surface food, suspended by grasses and other plants growing in the water, or lowly organised plant life such as algæ growing on the surface, or floating and decomposing rubbish.

(2.) That in more than ninety-five per cent. of cases their breeding ground is non-permanent. That the pools tend to last during, and for a short time after, the rains, and they are usually shallow.

(3.) They are rarely or never pools in an open piece of land unprotected by rocks, bush, or other vegetation, and that tend to be continually wind-swept.

(4.) They are never pools in which canes or tall reeds and bamboos grow, which exclude the light.

(5.) The larvæ are not found in pools which possess a continuous current of water, or if they occur in connection with these pools it is in those parts that are protected by vegetation from the current.

(6.) The Anophelinæ larvæ are not found in close association with their natural enemies, nor in any situation that is easily reached by them.

"This is well illustrated by two examples :

(*a*.) I have not found any larvæ in the swamps at Vieux-Fort nor in any pools of water that are in any way connected with the main swamp. This is because all the pools are reached by the 'Millions' fish, which will be described later.

(*b*.) I have not found larvæ in a lagoon at Anse-la-Raye ; but I have found them repeatedly in pools around the lagoon, and which are connected with the main sheet of water. The reason is that the lagoon contains numerous dragon-fly larvæ and Crustacea, which apparently do not invade the small connected pools in the same way as the 'Millions' fish.

(7.) After rains, fresh pools are formed in the valleys, along the edges of the sugar-cane fields, along the sides of roads, and along the irregular beds of the rivers, and these are not connected with the rivers, lagoons, or any main sheet of permanent water, in the neighbourhood. These are the situations in which the Anopheline larvæ are usually found.

(8.) *Cellia argyrotarsis* is found chiefly from the end of August to November, and usually in situations as described in (7), especially when there is protection afforded by matted decaying vegetation and the finer grasses ; they occasionally occur, however, in pools on the surface of which are fungi and algæ, and where there is little or no decaying matter or sedges. These pools occur in the sandy beds of rivers and are protected from the sun, wind and rain by the overhanging giant vegetation.

Cellia albipes is found chiefly after November, and in shallow water on marsh-lands, and is usually seen feeding on and protected by a certain alga, which grows in a network above and below the surface ; this network affords the larva protection from its natural enemies, except the 'Millions' fish which quickly penetrates it.

"I am performing laboratory experiments with the mosquito larvæ (ANOPHELINÆ), and find that they will not develop if there is an entire absence of surface food. A deep beaker was filled with marsh water and allowed to stand several days until all matter had sunk to the bottom ; larvæ were then placed in it ; they started to die after six days, and the last died on the fourteenth day. In other experiments they have lived longer but have not developed. Control experiments were of course always made and the larvæ (*Cellia albipes*) hatched out. Another experiment was made allowing sprayed water (imitation rain) to fall for twenty-four hours on the surface of water that contained larvæ. The larvæ were destroyed. I have also experimented with their food supply : sedges and weeds are sterilised and placed in sterilised distilled water, and the larvæ having been passed

through a number of vessels containing sterilised water (to wash them free from bacteria), are placed in this. They do not develop. If, however, they are supplied with sterilised algæ, they develop. These experiments seem to show that the larvæ are dependent on algæ, or certain decayed vegetable matter. These factors may be of some practical importance, as I will attempt to show later when discussing practical means of lessening the larvæ. I will now turn to the natural enemies of the larvæ, and describe them, together with experiments I have done to determine their practical possibilities.

"The chief among these in this island are the fish here known as 'Millions.' I believe there are two varieties of these (I am forwarding specimens of the second variety to the British Museum) : the one technically known as *Girardinus poeciloides* exists in the swamp at the north end of the island, and the other variety at the south end. The greater part of the island had none of these fish ; I have recently distributed them over certain districts.

"My experiments have all been made with the former, and were made to ascertain their power of destroying larvæ and their adaptability to varying surroundings.

(1.) I obtained about twenty fish from the swamps of Gros-Islet and placed them in two old spirit-barrels, which had previously been soaked in tanks for two months. In these barrels I have now bred many thousands, which have been variously distributed.

(2.) At first the fish would not live in iron tanks ; but by mixing a little water from rusty tanks with a large quantity of rain water, and gradually increasing the percentage of the rusty tank water, I obtained fish which would live and multiply in iron tanks.

(3.) In the same way I succeeded in immunising fish to darkness.

(4.) By gradually adding water from brackish swamps they are immunised to brackish water.

(5.) I have had great difficulty in getting fish to live and multiply in water at and above 100° Fahr. ; but I have now succeeded, and the difficulty I believe was entirely due to the dark incubator with which I was obliged to work, layers of fungi quickly appearing on the surface of the water, and their food material quickly decomposing. Continually changing the water and adding fresh food and allowing the sunlight to play upon the water each day, has enabled me to get fish to flourish at these higher temperatures. I have had difficulties with the lower temperatures ; but the experiments conclusively show that these fish can be gradually immunised to temperatures ranging from 101·5° Fahr. to 55° Fahr. ; and there appears to me no reason why higher and lower temperatures should not be employed, if a considerable period of time is used to obtain the immunity.

(6.) I once placed six fish in a kerosene tin containing numerous mosquito larvæ ; the next day all the larvæ had disappeared. I did not change the water ; at the end of three weeks there were twenty-three individuals. Shortly after this some of them began to die. They had thus lived and multiplied in two or three gallons of stagnant unchanged water.

(7.) It is almost impossible to state their exact power of destroying larvæ and pupæ in figures, as both larvæ and fish vary so greatly in size ; but this power is enormous, for I find two or three fish will soon clear a 10,000 gallon tank and keep it free from larvæ."

The next natural enemy dealt with is a small undetermined Crustacean of the sub-order Decapoda. This is stated to have a special value because it remains in mountain pools in which *Girardinus* cannot be established, owing to its habit of following the streams down to lower levels. The utility of these Crustacea is illustrated by an experiment, in which six of them were placed in a jar with several hundred mosquito larvæ ; the next day not a single larva remained.

Observations are also cited which suggest that in suitable small pools water-beetles and dragon-fly larvæ may serve to prevent the breeding of mosquitos ; and reference is then made to certain other possible inhibitive factors.

"One swamp that I have examined is overgrown with thick canes running to a height of twelve feet ; in this I have never found larvæ, the absence of light and warmth from the sun evidently preventing their development. I therefore suggest that these reeds might be grown to advantage on certain swampy waste lands.

"The following illustrates another method which might be applicable in certain situations. *Cellia albipes* is very common in the months of December and January. In a certain pool in which they were numerous, I raked the surface free from algæ and cleaned the edges of the pool from sedges ; it was a small pool, and this occupied me about five minutes. In a few days I searched the pool again but could find no larvæ, though they were still numerous in neighbouring pools that I used as a control. I have repeated this experiment with the same results. I have not decided the true reason of this, whether what I removed was their food or their protection from sun, rain or their natural enemies."

Finally, it is urged that "there is no reason why Neuroptera, Coleoptera and fish that are the natural enemies of mosquitos should not be introduced into other countries ; a general exchange and distribution might be followed by great results. The 'Millions' fish could certainly be carried to such a country as India, and there bred in tanks and immunised, protected and distributed to numerous and varied surroundings. The cost of breeding and distributing 'Millions' would be very small . . . .

"The 'Millions' fish are of considerable value for larger barrels and tanks, and, as far as I have been able to estimate, have no deleterious or unpleasant effect upon the water. The analysis of the water from a 5000 gallon tank, in which four to thirty fish had lived for one month, would pass as sufficiently pure for drinking purposes. In fact I have been totally unable to detect any effect whatever caused by the fish. The tanks from which I obtain drinking water have now been stocked with fish for several months."

The value of the fish, *Girardinus pœciloides*, as a destroyer of mosquitos seems now well established, and attempts have already been made to introduce it into the West Coast of Africa. The fish were brought over to the Zoological Gardens in London, and from there several consignments were despatched to West Africa, though in no case did the fish survive for long. But as there were certain unavoidable conditions in these experiments which were unfavourable, the results cannot be taken as final. We understand that not long ago a batch of *Girardinus* was imported into Mauritius, though no information with regard to the success or otherwise of the experiment appears to have yet been published. If successful, this island would be a very favourable point from which to attempt the establishment of the species in Africa.

On general grounds it would seem likely that a species belonging to a limited insular fauna would have considerable difficulty in maintaining itself in a continental area like Africa, where the struggle for existence would probably be far more severe than in its proper habitat. On the other hand, the mutual inter-relationship of living organisms is so complex that the wholesale introduction of a new animal might have deleterious results which at present it is quite impossible to foresee, and thus should not be too lightly undertaken.

It seems desirable therefore that before any serious attempt is made to colonise *Girardinus* in Africa, adequate investigations should be carried out with reference to the local enemies of mosquito larvæ, which might possibly be utilised in a similar manner. Indeed, there seems reason to believe that there already exist in Africa small fish which are capable of doing work similar to that done by *Girardinus* in the West Indies. For in West Africa, Dr. W. M. Graham has noticed the complete absence of mosquito larvæ from apparently suitable pools, which however contained numerous small fish (Bull. Ent. Research, i. p. 52). And the writer is informed by Mr. G. A. Boulenger, F.R.S., that there are various African species of small Cyprinodont fishes, belonging to such genera as *Fundulus* etc., which are nearly allied to *Girardinus*, and doubtless have very similar habits. The same authority suggests that the great abundance of "Millions" in Barbados is due to the

fact that it is the only species of fish in the island ; its capacity for withstanding competition is therefore not likely to be great.

The idea of distributing dragon-fly larvæ or water-beetles for the destruction of mosquitos would appear to be less promising. For these widely distributed insects would be capable, during their winged stages, of gaining access to every suitable piece of water in a given neighbourhood ; and therefore their absence from any pool would probably mean that it was unsuitable for their larvæ. Such an argument would not necessarily apply to fish, owing to their much more restricted opportunities for dispersal.

An adequate investigation into the natural enemies of mosquito larvæ in Africa offers a wide field for observation and experiment to anyone who may have the time and opportunity for undertaking the work.

AN INSECT ENEMY OF *GLOSSINA* IN DAHOMEY.

M. E. Roubaud (Comptes Rendus de l'Académie des Sciences, Paris, 1910, p. 505) gives the following account of some observations on the habits of a wasp of the genus *Bembex* :—

"So few entomophagous insects that prey upon tsetse-flies are known at present, that any observation in this connection is of real interest. Recently Picard (C. R. Soc. Biologie, lxvii, July 1909) has published the discovery by Dr. Bouffard, at Bamako, of a Hymenopteron which appears specially to select *Glossina* as its prey ; this wasp, of the genus *Oxybelus*, chases and captures these flies for the purpose of provisioning its nest.

"I have never observed the capture of *Glossina* by *Oxybelus*, although these Hymenoptera are very common in Tropical Africa on the bodies of domestic animals, especially cattle and horses, upon the skin of which they alight for the purpose of catching *Stomoxys* and other Diptera which may pass within their reach. Bouffard's observation constitutes the only case, which has been actually proved, of a predaceous Hymenopteron attacking *Glossina*. On the Congo, certain Europeans have assured us that they have seen wasps, the description of which applies sufficiently well to *Bembex*, darting upon tsetse-flies and carrying them off. I have not been able to confirm this statement during my residence in French Equatorial Africa, although my researches in this connection have been extensive, and I have frequently met with *Bembex* on the sand-banks of Stanley Pool. But observations which I have recently made in Dahomey enable me to place the matter beyond doubt.

"Along the banks of the river Wemi, some kilometres above the railway bridge, there is an area frequented by *Glossina palpalis* and *G. longipalpis*. In the immediate vicinity of the water and in the shade of the strip of forest along the banks, one finds *palpalis* almost exclusively, frequenting 'the vicinity of man' ; while further back, in the moderately dense scrub which adjoins the strip of forest, it is *longipalpis* which predominates.

"On taking a donkey into the zone infested by *longipalpis*, I observed almost immediately the arrival of several large *Bembex* * which assailed the animal after the manner of *Tabanus*, passing with a rapid flight around the breast and legs, without ever settling. After some moments, one of them seemed to me to dart upon a tsetse and carry it off ; but the movement was so rapid that I could not grasp the details. I then caught one of the *Bembex*

* Dr. Bouvier states that the species has been submitted to Dr. Handlirsch, who considers it to be new.

which still buzzed round the donkey, and placed it in a long glass tube, into which I also introduced a living *Glossina*. After flying for some minutes in a dazed manner along the sides of the tube, the *Bembex* perceived its prey, pounced upon it and pierced it with a single thrust of its sting. No sooner had I detected the movement of the abdomen than the fly appeared inert and with folded wings, lying longitudinally beneath the body of the wasp, which carried it firmly held between its posterior and middle legs. I repeated the experiment upon another *Bembex*, with the same result; in an instant the fly was paralysed by the sting, and placed in the carrying position. But after having flown about for some minutes in their glass prison, the wasps abandoned their prey in order to find a means of escape. The stung flies were absolutely incapable of any movement.

"The arrival of the *Bembex* around the donkey took place almost immediately the latter was introduced into the *longipalpis* zone. On taking the animal to various points of the area frequented by this *Glossina*, the same *Bembex* appeared. I then led it some distance away to the river bank, in the *palpalis* zone, but I did not see a single *Bembex* there, although the donkey was kept under observation for several hours.

"The wasps were thus exclusively frequenting the limits of the *longipalpis* area. I searched in vain for their nests, the ground being uniformly covered with dense vegetation, without any bare sandy patches suitable for their colonies."

The author attempts to explain the restriction of the wasps to the *longipalpis* area by the suggestion that they were attracted by the smell of the hippopotamus and antelopes which frequented this area, but not the *palpalis* belt adjoining the river. The explanation can hardly be regarded as satisfactory, for more than one reason. But in any case, the data are quite inadequate to justify any conclusions on the subject. To mention a single point. We need to know something as to the time of day and the weather conditions of the experiment; for the observations of the Peckhams on the North American *Bembex spinolæ* show that it never works more than 4 or 5 hours a day, and then only if the sun is shining ('Instincts and Habits of Solitary Wasps,' p. 62). With regard to Roubaud's inability to find the nest of his *Bembex*, we may recall Bates' statement concerning *Monedula signata*, a South American species of similar habits, that it had to go "at least half a mile" from its nest in order to reach its hunting grounds ('Naturalist on Amazons,' p. 182).

It would be useful to have some more exact observations as to whether the presence of the *Bembex* produces any appreciable diminution in the numbers of the *Glossina*.

SOME ENTOMOLOGICAL OBSERVATIONS MADE BY THE SLEEPING SICKNESS COMMISSION IN UGANDA.

In a recent part of the Proceedings of the Royal Society (Series B, no. 588), Colonel Sir David Bruce, C.B., F.R.S., and Captains A. E. Hamerton, D.S.O., H. R. Bateman and F. P. Mackie, have published several important papers dealing with the investigations of the Sleeping Sickness Commission of the Royal Society in Uganda. These contain various observations of considerable entomological interest.

The Natural Food of Glossina palpalis.

As a result of their experiments upon a large number of these flies in their laboratory at Mpumu, the authors found that *G. palpalis* fed with far greater avidity on birds than on monkeys, while they could hardly be tempted to feed on young crocodiles or lizards. From this it was at first supposed that under natural conditions *palpalis* would feed only on the blood of birds. However, the microscopical examination of the contents of the alimentary canal of 403 flies yielded the following results:—

"Two hundred and twenty *Glossina palpalis* were caught on various parts of the Lake shore, and at intervals extending over several months; they were examined about 24 hours after capture. The examination of their intestinal contents revealed the fact that about 27 per cent. contained the remains of blood, the majority of which was of mammalian origin. [Of the 60 cases in which blood was found, it proved to be mammalian in 20 cases, non-mammalian in 9, and non-recognisable in 31.]

"In the second experiment, 183 *Glossina palpalis* were caught at one spot where the food supply was abundant—birds and crocodiles—and the flies were examined at once.

"A much higher percentage (nearly 60 per cent.) contained the remains of a blood meal. The blood in the majority of the flies had been obtained from birds or reptiles, and of these the reptilian blood was twice as frequent as the blood of birds."

In this second experiment the actual number of flies containing blood was 108, the character of the blood being unrecognisable in 66 instances; of the remaining 42, 7 contained mammalian and 35 non-mammalian blood.

The Carrier of Trypanosoma pecorum.

The question as to the probable carrier of *Trypanosoma pecorum*, which causes a fatal disease in domestic animals, is discussed in another paper by the same authors.

It must be explained that *T. pecorum* is proposed as a new name in order to clear up the confusion which at present exists in the nomenclature of the *T. dimorphon* group. This new name is stated to include *Trypanosoma dimorphon*, *T. congolense*, the trypanosome discovered in Zanzibar by Edington, that from Portuguese East Africa and Zululand described by Theiler, and the species found in Northern Rhodesia by Montgomery and Kinghorn, and in Southern Rhodesia by Bevan.

It was found by experiment (one case out of four) that *T. pecorum* is capable of developing in a wild specimen of *G. palpalis*, and of infecting a healthy animal after a period of 21 days. But it is noted that in no instance did *Trypanosoma pecorum* appear in the blood of animals upon which freshly-caught Lake-shore flies had been fed; the only trypanosomes with which such flies were found to be naturally infected being *T. gambiense* and *T. virax*. It would appear from this that *G. palpalis* is probably not the common or chief carrier of *T. pecorum*.

With regard to TABANIDÆ, no experimental evidence is available as yet, owing (so the writer is informed by Sir David Bruce) to the impossibility of keeping these insects alive in captivity for more than two or three days. But the authors make the following suggestive comments on these flies :—

"There is some circumstantial evidence available to show that *Trypanosoma pecorum* is carried by TABANIDÆ. In the valleys round Mpumu Hill, so far as we are aware, there are no tsetse-flies at any time of the year. As a rule, there are a few TABANIDÆ. The cattle belonging to the Commission went down to the foot of the hill every morning to graze, and returned to their kraal on the top at sunset. Half of the herd went to the east of the hill and half to the west. On both sides there was a small valley or glen, through which ran a small stream. In these valleys during the year, as a rule, a *Tabanus* or two or a *Hæmatopota* could be seen, but they were in small numbers. Now it is a curious fact that at certain times of the year enormous numbers of TABANIDÆ will suddenly appear in places where only a few are, as a rule, to be found . . . . . So, in the same way, at Mpumu, the TABANIDÆ, which had been rare, suddenly appeared in swarms. They were first seen in the valley to the west of the hill in September, 1909, and a month later in the valley to the east. Soon after this the cattle, which had shown no signs of disease during the previous year, were found to be suffering from *Trypanosoma pecorum*. Those which grazed in the valley to the west were the first to be affected, and afterwards those which grazed to the east of the hill. The species of TABANIDÆ in this case was *Tabanus secedens*, Walk. In both groups of cattle there were cases of *Trypanosoma pecorum* disease, so that the TABANIDÆ had a reservoir from which to draw the virus.

"Another sudden epidemic of *Trypanosoma pecorum* disease occurred on Mr. Walsh's farm at Kabula Moliro, where 34 milch cattle died within two months in a herd of 300. The evidence is all against this epidemic having

been caused by tsetse-flies. During February and March, and again later in the year, during August and September, as many as 100 fly-boys were engaged scouring this district for biting flies. *Tabanus*, *Hæmatopota* and *Chrysops* were brought in, but not a single tsetse, although a reward of 5 rupees was offered for each specimen. The commonest *Tabanus* in this district during August was *variatus*, Walk. [a colour variation of *T. tæniola*, P. de B.].

"It may therefore, in our opinion, be concluded that the trypanosome disease caused by *Trypanosoma pecorum* can be carried from sick to healthy animals without the help of *Glossina*, but what other species of fly, if any, acts as carrier is merely a matter of speculation at present."

Experiments were made to test the belief, expressed by Montgomery and Kinghorn, that flies of the genus *Stomoxys* are capable of transmitting this disease; but although these experiments were persevered in for several months, they remained negative. The authors contend that "*Stomoxys* are so numerous in every part of the country, all the year round, that it seems inconceivable that they can act as carriers. From October, 1908, until the following September, although numerous cases of cattle with *Trypanosoma pecorum* in their blood grazed all day long with healthy cattle, yet not a single case of infection took place. The *Stomoxys* were exceedingly numerous all this time, forming a small cloud of flies round the cattle, and passing constantly from one animal to another, being driven hither and thither by the rapidly swishing tails. This is a natural experiment on a large scale. It will therefore require very convincing proof to bring this Commission to the belief that *Stomoxys* are carriers of this disease."

Cattle as a possible Reservoir of the Virus of Sleeping Sickness.

It has hitherto been generally considered that man himself constituted the main reservoir of *Trypanosoma gambiense*, but seeing that the *Glossina palpalis* on the shore of Victoria Nyanza have remained infective for some two years after all the natives had been deported, it was necessary to reconsider that opinion.

As cattle have been numerous in the past along the Lake shore it was surmised that they might prove to be a possible reservoir of the disease; and if so, the same would probably be true of wild antelopes, whose presence might thus account for the continued infectivity of the flies on the Lake shore.

As a result of various experiments, the following general conclusions were reached:—

"It has been proved by experiment that cattle may act as a reservoir of the virus of Sleeping Sickness, and that healthy animals may be infected from them by means of *Glossina palpalis*.

"It has been proved that cattle in the fly-area do naturally harbour *Trypanosoma gambiense.*

"It is therefore possible that the cattle and antelope living in the fly-area may act as a reservoir, and so keep up the infectivity of the *Glossina palpalis* for an indefinite period, but there is no proof up to the present that this actually takes place in nature."

Mechanical Transmission of Sleeping Sickness.

Until the beginning of 1909 it was generally supposed that trypanosomiasis was conveyed from one animal to another by a purely mechanical process, that is to say, that individuals of the protozoon remained adhering to the proboscis of the fly after its feed, and were thus transferred to the next animal bitten. But Dr. Kleine's observations, at the end of 1908, showed that in some cases at least the parasite undergoes some process of development in the fly before it can infect a fresh animal. Nevertheless it was still usually held that mechanical transmission was the commoner method of infection. The experiments of the authors were directed to ascertain the validity of this assumption.

The method adopted was to place a cage of flies upon an infected animal, and while they were feeding to transfer it suddenly to a healthy animal, and backwards and forwards for 10 to 15 minutes. The animals used in these interrupted feedings were: monkey, ox, goat and fowl; and the experiments lasted generally for a week to 12 days each. In five such experiments positive results were obtained twice, the disease being transferred in one case from a monkey to a monkey, in the other from a monkey to a goat.

On the other hand, ten experiments were made in which the transference of the flies from the infected to the healthy animal was not instantaneous, the feedings being separated by intervals varying from half an hour to 48 hours. The duration of each experiment was generally 12 or 13 days, and the number of flies used in each case varied from 7 to 120, with an average of about 50. Only monkeys were used in these experiments, and in every case the results were negative.

The general conclusions arrived at by the authors are :—

"1. The mechanical transmission of Sleeping Sickness by means of *Glossina palpalis* can take place if the transference of the flies from the infected to the healthy animal is instantaneous—that is, by interrupted feeding.

"2. This mechanical transmission does not take place if an interval of time comes between the feedings.

"3. Mechanical transmission plays a much smaller part, if any, in the spread of Sleeping Sickness than has been supposed."

CURRENT NOTES.

Report of Cape Government Entomologist.

From the Report of the Cape Government Entomologist for 1909 it appears that that most intractable of pests, the Codling Moth, is slowly extending its range in South Africa and has now reached Johannesburg. The introduction of the Spanish Ichneumon (*Caliephialtes messer*) has not so far proved successful; nor does it seem likely to be of any practical value for keeping the Codling Moth in check; for Mr. W. W. Froggatt has shown (Official Report on Fruit Fly &c., Sydney, 1909) that this much advertised insect has been a complete failure in California, where it has been given a very thorough trial. The discovery of a local egg-parasite, *Trichogrammoidea lutea*, Girault, is recorded, and this insect may prove of value as a partial check.

Mr. Lounsbury points out that two Scale Insects, *Saissetia oleæ* and *Aulacaspis pentagona*, which are very serious pests in some other parts of the world, are widely distributed in South Africa, but their numbers are so restricted by local enemies that they cannot be classed as pests. He is endeavouring to obtain supplies of the local parasites for exportation. He has also made the interesting discovery that the highly destructive Olive Fly of Mediterranean countries occurs sparingly on wild and cultivated olives in Cape Colony, but the damage done is quite trifling. Numbers of a Hymenopterous parasite of the family BRACONIDÆ have been bred from infested fruit, and it is hoped that this may prove a valuable ally, if it can be established in European olive groves.

The strikingly successful demonstration of the value of Mr. Mally's remedy for Fruit Fly (*Ceratitis*) * is regarded by Mr. Lounsbury as perhaps the most notable achievement of his Office during the year. "Some of the most prominent fruit growers in the Western Province have put the measure to the test in the present fruit season (1909–1910) and have had most gratifying success." It is also anticipated that the remedy will serve for the control of the Melon Flies (*Dacus*), which do serious damage to cucumbers, melons, pumpkins, etc.

Notes on Glossina fusca.

The following interesting notes on *Glossina fusca* have been kindly sent by Dr. Meredith Sanderson, from Karonga, at the north-western corner of Lake Nyasa :—

"At the suggestion of Mr. Neave, who has just arrived here, I am sending you this preliminary unofficial note on my observations of *Glossina fusca*.

* See above, page 170.

As you will doubtless remember, the fly has been several times reported as occurring at Kaporo, near the River Songwe. On exploring the surrounding country, I find that it extends over a much larger area than hitherto supposed. The country consists of a large plain extending from a line of foot-hills to the lake (Nyasa), a distance of from 6 to 10 miles, and similar country continues north and south. This plain is only slightly above the lake level (1670 ft.), and is intersected by numerous streams. The latter are fringed with dense bush,—large trees and undergrowth,—and it is on these rivers, and only where there is bush, that I have found the fly. The grass-covered interlying areas are free from fly, though I am informed by the natives that it is prevalent all over the country during the rains, at which time practically the whole country is under water.

"I was able to catch a few specimens in the early morning, but none during the heat of the day; they were present in large numbers, however, immediately before sunset, when they bit freely. I had with me a young bullock, which I used to attract the fly. The fly was all of one species, viz. *G. fusca*, my determination of which has been confirmed by Mr. Neave. It is interesting to note that although cattle are exposed to the fly, as far as I can learn they remain healthy. In one place, however, near the source of the Kaporo River, it has been found, after repeated attempts, impossible to keep cattle. There is a large herd of buffalo in the immediate vicinity, and I intend to investigate whether these are acting as carriers of some organism. These observations were made in June. A thorough investigation was not possible owing to administrative work; but I am resuming the work this month, and will send you a full account, with specimens, map, etc."

Moth Larvæ destroying Tobacco.

Specimens of the Noctuid moths, *Chloridea obsoleta*, F. (= *Heliothis armigera*, Hübn.), and *Euxoa* (*Agrotis*) *longidentifera*, Hmp., have been received from the Rhodesia Museum, Bulawayo, with the statement that the larvæ of these species were very destructive indeed to tobacco in that neighbourhood during last season (1909–10).

A Millipede injurious to Cotton.

Mr. C. C. Gowdey, the Government Entomologist in Uganda, records a new and somewhat unusual cotton pest. This is a millipede of the genus *Odontopyge*, which attacks the planted cotton seed as it is sprouting. It appears to have caused a considerable amount of damage during the planting season. It is possible that poisoned bait, as used for locusts in South Africa, might prove an effective remedy.

A Locustid injurious to Man.

Dr. C. A. Wiggins, Acting Principal Medical Officer for Uganda, has forwarded from Entebbe examples of a large wingless Locustid, *Enyaliopsis durandi*, Luc., concerning which he says: "The bite of this insect gives rise to a very nasty eruption, which may extend over the whole body, with high temperature and general malaise. The skin at the site of the bite

Enyaliopsis durandi, Luc.; natural size.

sloughs away and generally leaves a large deep cavity, which heals very slowly." It is difficult to understand the reason for these symptoms, as the insect possesses no poison glands. The writer has often seen immature specimens of the allied *E. petersi*, Schaum, emit a clear yellow fluid from the sides of the body when handled; but the fluid was never observed to have any deleterious properties. A number of allied species occur throughout Tropical Africa.

Copper Sulphate and Mosquito Larvæ.

With reference to the possibility of eliminating mosquito larvæ by destroying the algæ upon which they feed, a reviewer in the 'Lancet' (29th July, 1910) makes the following comments:—"In connection with this subject we may mention the influence of copper upon the growth of algæ. In the 'Lancet' of October 28th, 1905, p. 1269, we reported some experiments in which it was shown that the addition not only of minute quantities of copper salts, but the presence of the clean metal also, rendered the water free from algæ, as well as odourless, colourless and fit for consumption; and it was further reported that micro-organisms were destroyed.

Apparently the addition of one grain of copper sulphate to one gallon of water was, under certain conditions, sufficient to destroy the vitality of the typhoid bacillus. This subject has received serious practical attention by the United States Department of Agriculture, and an interesting report was issued in 1906 by Mr. Karl F. Kellerman and Mr. T. D. Beckwith on behalf of that Department. We have ourselves found that sulphate of copper in a very small proportion (roughly, an avoirdupois ounce in about 120 gallons of water—*i. e.*, under a grain to the pint) will prohibit the growth of algæ in an ordinary garden rain-water tank, and possibly this method may be worth a trial."

Tsetses attracted by moving objects.

In a letter to Mr. E. E. Austen, Dr. A. E. Neale gives the following notes on a peculiar habit which he has observed in two species of *Glossina*:—

"During my last tour, in Northern Nigeria, I spent some days unsuccessfully searching for tsetse-flies in a certain area in which I felt sure they must exist. On these occasions I was always on foot and moving slowly and carefully. A little later, I had occasion to go through this belt on a bicycle. The native path was fairly good and I was riding fast, when soon I became aware that I was being besieged by tsetses. They settled all over me, including my hands and face, and being unable to beat them off with one hand, I had to dismount. Having no net with me at the time, I was able to catch only a few specimens with my handkerchief, these proving to be all *palpalis*, with the exception of one *tachinoides*. I was now quite free from flies and mounted the bicycle again, but no sooner had my pace become fairly fast, than I was again besieged by tsetses, and was compelled to beat them off as before. I repeated this several times, and found that whilst walking I was not attacked, but as soon as I was travelling fast I was immediately surrounded. This belt was about 3 miles wide. Horses in this district all went down with tsetse disease.

"This portion of the country abounded in game, chiefly hartebeeste, roan, kob, oribi, duiker, harnessed antelope, reedbuck, and occasional waterbuck.

"It appeared to me that these flies are attracted by fast moving animals, which would account for my being specially attacked whilst riding fast on the bicycle. I repeated my experiments later, by walking quietly with the bicycle right into the belt, without encountering a single tsetse; but when I mounted and began riding fast, I was again besieged, and the faster I rode the more furiously I was attacked.

"I have noticed a somewhat similar experience on the river. When moving very slowly in a canoe, as when fishing, I do not ever remember having been troubled by tsetses. But when being poled fast, with the stream in one's favour, or when in a small steamer, I have had *Glossina* settling on board.

"The district referred to in these notes lies between the Kaduna and Kara Rivers ; Wushishi, on the opposite side of the Kaduna River, being the nearest town—an old war camp."

A possible remedy for the Bots of Gastrophilus.

M. P. Portier (C. R. Soc. Biologie, 1910, p. 1056) points out that hitherto all attempts to destroy the bots of *Gastrophilus* in the stomach of the horse have failed. Such remedies as corrosive sublimate, salts of arsenic, thymol, spirits of turpentine, tincture of pyrethrum, etc., have been used with little effect, or have even proved fatal to the horse.

He attributes these powers of resistance on the part of the larvæ to the possession of an extremely effective mechanism in the tracheal system, which prevents the invasion of the body by poisonous liquids (see C. R. Soc. Biologie, 1909, p. 568). So effective is this contrivance, that these larvæ have been placed for three or four hours in alcohol, spirits of turpentine, corrosive sublimate, castor oil, etc., without being seriously affected thereby. From his examination of the tracheal system, he concluded that a remedial liquid to be effective must possess the following properties :—It must be capable of moistening the chitin, which is a hydrofuge ; it must have a very feeble surface tension, in order to prevent the phenomenon of gaseous adsorption, which is so marked in these insects and which is so efficacious a means of protecting the stigmata from the invasion of external liquids; and finally, it must possess these qualities in an acid, as well as a neutral, medium.

When almost on the point of abandoning his search for such a liquid, it occurred to him that bile possesses all these properties ; and actual experiment showed that when *Gastrophilus* larvæ were placed in even a weak solution of bile (1 per cent.), the liquid rapidly entered the tracheal system. By adding suitable remedies to the bile, the largest larvæ could be killed in less than an hour.

M. Portier points out that larvæ of *Gastrophilus* have only been found in just those very animals in which a gall-bladder is wanting, namely, the EQUIDÆ, the elephant and the rhinoceros ; but, as a matter of fact, this is by no means a complete list of the mammals in which there is no gall-bladder. The author argues that this correlation cannot be regarded as a simple coincidence, and suggests that in animals having a gall-bladder the bile may regularly regurgitate into the stomach and so destroy any larvæ. He also suggests that ruminants are protected by the fact that the bots can only permanently establish themselves in an acid medium ; in a neutral or alkaline medium they are rapidly attacked by parasitic organisms.

A Method of rearing the Larvæ of Stomoxys.

M. Maurice Langeron (C. R. Soc. Biologie, lxix. 1910, p. 230) states that he has found moistened bran to be an excellent medium in which to breed the larvæ of *Stomoxys*, the bran having first been sterilised by boiling, to prevent the development of mould, which is so often fatal to larvæ reared in horse-dung, etc. He agrees with Newstead that darkness and great humidity are essential for success. The eggs of *Stomoxys calcitrans* were easily obtained by isolating female flies in glass tubes, in which they oviposited readily. The eggs thus obtained were always fertile and hatched in the tubes after two, three, or four days, according to the temperature. The female always died a few hours after the eggs were laid.

COLLECTIONS RECEIVED.

The thanks of the Entomological Research Committee are due to the following gentlemen who have kindly presented collections of insects (received between 1st July and 30th September) :—

Dr. A. H. Barclay :—179 Culicidæ, 32 Tabanidæ, 2 *Auchmeromyia* with 17 larvæ, 43 *Glossina*, 196 other Diptera, 299 *Clinocoris* and 74 ticks; from Fort Johnston, Nyasaland.

Dr. H. A. Bödeker :—3 Culicidæ, 9 *Glossina*, 1 *Stomoxys*, 17 Tabanidæ, 1 Dragonfly, 1 Hemipteron and 9 ticks; from the British East Africa Protectorate.

Dr. Collett :—19 Culicidæ, 5 Tabanidæ, 1 *Glossina*, 15 other Diptera, 6 Coleoptera, 7 Hymenoptera and 1 Orthopteron; all from Opobo, S. Nigeria.

Mr. G. C. Dudgeon :—6 Coleoptera, 2 Hymenoptera, 4 moths, and 44 Hemiptera; from the Gold Coast and Nigeria.

Mr. J. H. J. Farquhar :—29 Lepidoptera, from Itu, Nigeria, and Kamerun.

Mr. J. H. de Gaye :—2 Tabanidæ, 3 other Diptera, 173 Coleoptera, 7 Hymenoptera, 4 Neuroptera, 9 Hemiptera, 3 Homoptera and 4 Orthoptera; from Lagos.

Mr. C. C. Gowdey :—17 Tabanidæ, 10 other Diptera, 37 Coleoptera, 38 Hymenoptera, 16 Lepidoptera, 5 Neuroptera, 8 Hemiptera, 4 Homoptera and 7 Orthoptera; from various localities in Uganda.

Dr. G. M. Gray :—55 *Glossina* and 50 Tabanidæ; from Aro, S. Nigeria.

Dr. R. W. Gray :—19 *Glossina*, 7 Tabanidæ, 4 *Clinocoris*, 50 Collembola and 15 ticks; from Benin, S. Nigeria.

Dr. T. Hood-Rankin :—3 *Glossina*, 11 Tabanidæ, 7 other Diptera, 2 Hymenoptera and 1 moth; from Aboh, S. Nigeria.

Dr. E. J. Kelleher :—6 *Chrysops silacea*, from Sapele, Southern Nigeria.

Mr. Harold H. King :—8 Tabanidæ, 4 *Phlebotomus*, 19 *Lyperosia*, 3 bot-fly larvæ, 11 Siphonaptera, 13 Anoplura, 7 Coleoptera, 49 Chalcididæ, 172 Termitidæ and 9 ticks; from Khartoum.

Mr. S. A. Neave :—33 *Glossina*, 8 *Stomoxys*, 96 Tabanidæ, 67 Culicidæ, 20 Hippoboscidæ, 114 other Diptera, 18 Siphonaptera, 40 Mallophaga, 57 Anoplura, 1037 Hemiptera, 46 Homoptera, 2675 Coleoptera, 627 Hymenoptera, 2467 Lepidoptera, 28 Dermaptera, 357 Orthoptera, 147 Neuroptera and 27 Acari; from Nyasaland.

Dr. J. E. S. Old :—46 Tabanidæ, 13 *Stomoxys*, 11 *Auchmeromyia*, 197 other Diptera, 122 *Clinocoris*, 147 Anoplura, 23 Coleoptera, 7 Hymenoptera, 3 Lepidoptera, 44 Orthoptera, numerous galls, 355 ticks and 6 other Arachnida; from Blantyre, Nyasaland.

Dr. E. H. Allon Pask :—9 fleas, 2 lice and 16 ticks; from Dowa, Nyasaland.

Dr. W. H. Sieger :—57 Culicidæ, 52 Tabanidæ, 2 *Glossina*, 3 Hippoboscidæ, 27 other Diptera, 4 Coleoptera, 14 Hymenoptera, 11 Lepidoptera, 2 Rhynchota, 2 Orthoptera and 2 Arachnida ; from Yaba, Lagos.

Mr. J. J. Simpson :—341 Culicidæ, 551 Tabanidæ, 61 *Glossina*, 5 Hippoboscidæ, 184 other Diptera, 13 Siphonaptera, 23 Hemiptera, 7 Homoptera, 52 Coleoptera, 89 Hymenoptera, 229 Lepidoptera, 10 Neuroptera, 17 Orthoptera, 8 ticks and 3 other Arachnida ; from Southern Nigeria.

Dr. A. W. S. Smythe :—879 Tabanidæ and 20 *Glossina* ; from Forcados, Southern Nigeria.

Dr. Hugh S. Stannus :—21 Culicidæ, 23 Tabanidæ, 5 *Glossina*, 21 *Stomoxys*, 2 *Auchmeromyia*, 45 other Diptera, 19 Dipterous larvæ, 25 Siphonaptera, 44 Anoplura, 8 Coleopterous larvæ, 2 Hymenoptera, 138 ticks and numerous parasitic worms from lion, horse, ox, calf, sheep and fowl; from Zomba, Nyasaland.

Dr. C. A. Wiggins :—384 Culicidæ, 4 Tabanidæ, 12 other Diptera, 2 Coleoptera, 2 Hymenoptera, 3 Neuroptera, 3 Orthoptera and 16 ticks ; from Entebbe, Uganda.

In addition to the above further consignments have been received from Dr. J. E. S. Old and Mr. S. A. Neave, which it is not possible to enumerate at present.

THE PREVALENCE, DISTRIBUTION AND SIGNIFICANCE OF *STEGOMYIA FASCIATA*, F. (=*CALOPUS*, Mg.), IN WEST AFRICA.

By Sir RUBERT BOYCE, F.R.S.

With a description of the Mosquito and its nearest African allies by

Robert Newstead, M.Sc.

(Maps.)

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I. Introduction.

Having taken part as a volunteer in the great yellow fever epidemic of 1905 in New Orleans, I was later in the same year sent by the Colonial Office to enquire into yellow fever in British Honduras and the adjacent Central American Republics.

In 1909 I was sent by the Colonial Office to investigate an outbreak of this disease in Barbados, and when there, I was asked to proceed to the other West Indian Islands, and to British Guiana, in order to examine their position from the point of view of yellow fever.

Therefore, when yellow fever made its appearance on the West Coast of Africa this year, 1910, I again gladly availed myself of the opportunity held out to me by the Colonial Office to proceed there to study the circumstances of the outbreak.

Knowing from my previous experiences the great importance attached to the presence of *Stegomyia fasciata* in large numbers in any tropical town, I was astonished to find that in very many large towns on the West Coast this species was much more abundant, according to my experience, than in either

British Honduras, the Latin Republics of Central America, or the West Indies.

Yet it is well known that little importance has up till now been attached to this very significant fact, and it is for this reason that I publish in the present paper the results of my own observations and investigations.

I trust that this survey will bring home to the Medical Officer on the West Coast the certainty that yellow fever is endemic, and that yellow fever must be reckoned with, as long as the *Stegomyia* is the prevailing mosquito. I hope, moreover, a further result will be that, just as in Tropical America and in the West Indies, a concerted, well organised, attack will be made upon the breeding places of this species of mosquito. As will be gathered from my observations, this is not a very difficult or expensive task. It is eminently practical, and, if properly carried out, will, I am convinced, show its beneficial effect in a very greatly reduced sickness and mortality rate in the West African Colonies.

In this paper I have brought together the observations which I made when on the Gold Coast, in Lagos (Southern Nigeria), and in Sierra Leone and the Protectorate, and the records which I have been able to collect regarding Dahomey, Togoland, the British Gambia, Senegal and other parts of Africa.

II. Investigation of Breeding Places.

I have learnt as the result of long experience that the only sure way to arrive at a correct estimation of the number and kinds of mosquitos present in a town, is to make a systematic house to house inspection of all articles containing water. For this purpose, it is necessary to have a block- or house-plan of the town, and to divide the town up into sections, and then to work over each section house by house.

In specially printed note-books, divided into columns for cisterns, tanks, barrels, tubs, wells, kerosene tins, 'odds and ends,' broken crockery, bottles, and 'other receptacles' (as flower vases, lily tubs, etc. etc.), the number of water-containers found is systematically entered, and a note made as to whether *Stegomyia* larvæ are present or absent.

When I and my assistants (usually the Sanitary Inspectors) have made our survey, all the odds and ends and discarded tins are collected together and brought out into the street for the dust-cart to remove; if larvæ are found in barrels or cisterns the water is emptied, or if that is impracticable, kerosene oil is poured in; the occupier of the house is admonished and reasoned with, and the sanitary inspector enters the name and address of the offender in his book, and if the nuisance occurs again, action is taken. In order to discover all the discarded tins etc., it is very often necessary to get the wild bush in

the compound cleared; and this invariably discloses a large number of receptacles containing stagnant water and harbouring innumerable larvæ.

In addition to the examination of the yard, the interior of the house must not be overlooked, for it is quite a common occurrence to find the larvæ of *Stegomyia* in collections of water allowed to remain stagnant in the house; for example, in flower vases, saucers of flower pots, glasses employed for striking cuttings of the croton plant, water ewers, indoor water cisterns, fire buckets, etc. I have found the larvæ on more than one occasion in the water used for cooling the irons in a blacksmith's shop.

The abundance or otherwise of the *Stegomyia* may be influenced by the nature of the occupation of the towns-people. In a fishing village or where canoes are abundant, enormous numbers of larvæ are frequently harboured in the rain water which collects in the canoes. If there is much cooperage

Border of inverted bottles round a flower-bed; a favourite breeding place for *Stegomyia fasciata*.

rain water often collects on the upturned bottoms of the barrels and harbours larvæ; in some villages, conch or snail shells are abundant, and these contain larvæ; in other places calabashes or cocoanut husks abound. In Belize, British Honduras, I found vast numbers of larvæ in the irregular depressions and forks in the logs of logwood piled up on the wharf ready for the steamer; the purple, almost black-coloured, water in the holes did not in the least affect the larvæ. Then, again, every country has its own special receptacles

liable to contain larvæ. In Louisiana, Central and South America, the large wooden rain-water vats are the common offenders. In many of the West Indies large stoneware jars (olive jars) create a nuisance. In Trinidad the "antiformicas" placed around flower-beds to protect the flowers from the attacks of the umbrella ant, usually harbour larvæ. In Freetown the habit of making 'ornamental' borders to flower-beds by sinking into the earth a row of inverted bottles is a fertile source of *Stegomyia*; the cup-shaped depression at the bottom of the bottles holds water, and in these the *Stegomyia* deposits her eggs. Imperfectly broken glass on walls is another source. Rot-holes of all kinds in trees, the axils of the Aroideæ, of the Traveller's Palm, and of many other plants, form receptacles which may prove a nuisance. I have found larvæ breeding in the puddles formed on the flat mud roofs of houses in Cape Coast Castle. The roof-gutters of houses are common receptacles. Less frequent breeding places are marsh-holes, puddles and drains. I have found *Stegomyia* larvæ in all these latter places, but, in my opinion, less frequently. In my experience, this mosquito most frequently selects, for breeding purposes, wooden receptacles of all kinds, especially barrels in which there is a thin coating of minute green algæ: next in frequency, all small collections of water in tins and cans of every description, when protected by the shade of foliage from the sun's rays and the heavy rains. In West Africa I have not met with epiphytes growing in any abundance upon the trees, indeed the Bromeliaceæ are conspicuous by their absence. In the West Indies the reverse is the case. When they are present they collectively hold a large quantity of water and support a very large number of larvæ.

As the investigator gains experience two facts begin to strike him. Firstly, the very small quantity of water, from a teaspoonful upwards, which will suffice as a breeding place for the *Stegomyia*; and on this account, the smallest odds and ends which may contain water should be examined. Secondly, the immense number of discarded empty sardine tins, milk tins, meat tins and tin cases of all kinds which are to be found in all towns opening up to commerce. A veritable tin can invasion extends up from the coast towns into the interior villages. The more traders, the more tin cans: the nearer the more primitive villages are approached, the less become the white traders and the less, in consequence, the number of discarded tins. In other words, tinned foods of all kinds, oil tins and tin packing cases are most abundant where there are white settlers and traders. This has brought about a condition which immensely favours the development of the *Stegomyia*. The total water-holding capacity of these discarded tins is very great indeed, vastly greater than the inexperienced would at first sight suppose. For the tins are not always obvious when you enter a compound; the fact being that the larger number are concealed amongst the weeds and low bush which invariably is present in the majority of compounds, and on waste places in

and immediately around towns and villages on the banks of rivers and streams, and along the seashore. These receptacles becoming filled by the first shower of rain, and being to a great extent protected from the sun's rays by the overhanging grass and leaves, the water does not evaporate and ideal breeding places are thus afforded for the *Stegomyia*. To sum up, the breeding places of the *Stegomyia* are almost exclusively *artificial*, including all receptacles in which, by accident or design, water is stored, and not repeatedly renewed. It is for this reason that all anti-mosquito by-laws must be specifically directed against *stagnant water*, which, in the tropics, has been rightly termed 'the great enemy of mankind.'

Stegomyia fasciata is usually regarded as a clean-water breeder, and so it is for the most part; occasionally, however, it will be found in very dirty water, in company with the larvæ of various species of *Culex* and *Chironomus*. I have sometimes met with it in drains and marsh-pools in the vicinity of houses.

The striking feature about the *Stegomyia*, as Beauperthuy long ago recognised, and one which every investigator soon appreciates, is its essentially *domestic* nature. It is the true '*house-haunting mosquito*' of the tropics, and, like the cat and dog, is never far from the abode of man. I have never seen them in swamps, far away from human habitations.

These features in the life-history of the *Stegomyia* render it easily amenable to control, or even extirpation. It is for that reason that it is very essential in every town to make a precise survey to ascertain where the *Stegomyia* is breeding.

III. *Stegomyia* Surveys.

To arrive at an accurate percentage in making a *Stegomyia* survey, I adopt either the house or the compound as the unit. In some countries it is very easy to make the house and its yard the unit. In less advanced countries the towns and villages are divided up into compounds or lots, and in each of these there may be 2, 4, or 6 houses. Therefore, if the 'lot' or 'compound' is taken as the unit, the number of houses in each should be recorded where possible, but it is not always easy.

In examining a house and its attached yard, the probability will be that the larvæ of the *Stegomyia* will be found in several receptacles. I make a record of this in my note-book, as it bears upon the question of the total numbers of the mosquito; but for calculating the percentage I regard it simply as one house in which the *Stegomyia* is present. In the case of a compound or yard containing more than one house, if I find receptacles in that yard harbouring larvæ, I assume that all the houses are infected, as they are equally exposed to the *Stegomyia*.

The aim and object of the survey is to ascertain the number of houses in

a town or village in which, or immediately around which, *Stegomyia* are breeding, and which, therefore, are infested with the mosquito. I have worked out these percentages for a great number of the larger towns in the West Indies and British Guiana, and also in British Honduras, and I am of opinion that they give a very fair idea of the distribution of the *Stegomyia*.

The size of the vessel in which the larvæ are found only affects the question of the total number of the insects. The presence of only two larvæ in a teaspoonful of water, contained perhaps in a snail shell or the broken end of a bottle fastened into a wall, is not less significant than the presence of hundreds of larvæ in a barrel: for it shows how ubiquitous that particular mosquito must be.

IV. Some characteristics of the *Stegomyia* and its Larvæ.

Having now had several years' experience of this mosquito, I record here those features which appear to me to be most characteristic. The most salient point is the essentially domestic instinct of this mosquito, which is, above all others, the most 'house-haunting' species. I have never found it breeding far from the abode of man, not more than, say, 50 to 100 yards *. It is fond of dark situations, breeding preferably in shaded barrels and odd-and-end receptacles. Therefore a most favourite site is any water vessel, such as a jar or barrel, stowed away in a corner in the kitchen, or in a bedroom.

The mosquito avoids windy places, and therefore selects not only quiet stagnant water, but places where the air is stagnant. As soon as the imago emerges from the pupa, it makes for the dark places in the house. It alights preferably on dark or black material. So far as I have been able to judge, I do not think that it flies any great distance at one time, although of course its travelling may be very greatly assisted by the cover of trees or a long line of huts, which would enable it to progress from point to point, sheltered from wind and rain. Some observers give 100 yards as its maximum distance of flight. Whatever this may be, however, I consider that it may safely be said that this mosquito does not, as a rule, fly long distances. It seeks cover as soon as it emerges from the pupa, but it may travel from house to house, and is certainly capable of entering ships moored in rivers. In conformity with its house-haunting domestic nature is the fact that it is probably the most common mosquito found on ships; numerous observations in recent years, and the endless records of yellow fever on board-ship in the nineteenth century, amply testify to this fact. Given the suitable conditions of freedom from draughts, darkness and warmth, it can remain secreted for

* Bouffard places the distance limit at 100 metres; Le Moal gives it as 250 metres.

weeks in the holds, galleys, engine-rooms, or bunks of a ship. It is for this reason that it is so essential to screen ships which trade in rivers in yellow fever countries, or to insist that they shall be moored several hundred yards from shore.

With regard to the appearance of the mosquito itself, it is very readily recognised. On the wing, it appears grey in colour, and it glides from point to point just like a small bit of 'fluff.' On account of its colour and markings, it is known as the 'Scots Grey,' or the 'Tiger' mosquito. When it alights, the two long banded white hind legs continually waving up and down are very characteristic.

As I have said above, this species is usually, though by no means always, a clean-water breeder; this habit is doubtless due to the fact that, being essentially a house-frequenting mosquito, it naturally seeks out the water nearest at hand, and this is, of course, the domestic drinking, cooking and washing supply. It has therefore come to be known as a clean-water breeder; so much so, that its presence in water is taken as evidence of the good quality of the latter. From this belief has sprung a further deduction, namely, that the presence of the larvæ in water is beneficial; for it is supposed that they feed on harmful bacteria, and therefore tend to purify the water. I have made experiments to determine whether there is any truth in this belief, and I have found, as indeed might be expected, that the contrary is the case, and that water containing larvæ becomes much more crowded with bacteria than water without larvæ*. The natural food of the larvæ appears to consist of minute algæ.

Stegomyia fasciata bites in the daytime as well as at night†, and in my experience it is noiseless. When it has bitten a person suffering from yellow fever in the infectious stage, the virus, whatever its nature, requires 12 to 13 days to mature in the body of the mosquito before the latter is capable of transmitting the infection. This period is known as the "extrinsic incubation period." When once the mosquito is infected, all evidence points to the fact that it retains the infection for a very long period; three months has been noted, but it is quite possible that the infection lasts as long as the life of the mosquito. It is precisely because of the length of duration of the infection in the *Stegomyia* that it is possible to explain the well known sporadic outbreaks of cases of yellow fever, which frequently occur long after an epidemic is supposed to have disappeared. There is no conclusive evidence that the infected female *Stegomyia* transmits the virus to its eggs and larvæ.

* 'The effect of Mosquito larvæ upon drinking water,' Boyce & Lewis, Annals of Tropical Medicine & Parasitology, March 1910.

† [Goeldi ('Os Mosquitos no Pará,' p. 103) states that *S. fasciata*, in Pará, bites persistently by day, and that while it does bite also at night, such cases are certainly exceptional.—Ed.]

The following entomological notes have been kindly furnished by Mr. Newstead :—

V. Differential Diagnosis of *Stegomyia fasciata*, with descriptions of two nearly allied species. (By R. Newstead, M.Sc.)

Stegomyia fasciata, F.

General characters as seen with a pocket lens, × 16 :—Head dark, with a distinct double white median line and with white lines laterally and round

Stegomyia fasciata, F. (=*calopus*, Mg.) ♀;
the mosquito which carries yellow fever.

the eyes; palpi black, white at the tip; proboscis black. Thorax brown, with *two brilliant silvery broad lateral curved lines*, which converge from in front towards the middle of the thorax, there becoming much narrower and continuing parallel to one another as far as the scutellum; in the middle there

are two parallel yellowish or whitish lines running the whole length of the thorax. Scutellum very marked, owing to its being completely covered with silvery white scales. Pleuræ with several patches of brilliant white scales. Abdomen dark, with white bands on the bases of the segments. Legs black, the femora for the most part pale beneath, in many cases with a distinct white line running from the base almost to the apex and situated on the inner surface, a white spot is also visible at the apex ; tibiæ black ; the first and second pair of legs with two white bands on the tarsi, the hind pair with five white bands, the last joint being wholly white.

Wings with the veins darkly scaled, the upper fork cell being distinctly longer than the second and its base slightly nearer the root of the wing.

Length 3·5 to 5 mm. ; the average length is about 4·5 mm., but very small specimens are often met with.

The following descriptions of two closely allied species of mosquitos may assist the student in determining *Stegomyia fasciata* :—

Stegomyia (**Scutomyia**) **sugens**, Wiedemann.

Characters as seen under a lens, × 16 :—Head black, with a thin median whitish line and a white patch on each side ; palpi black, white at tip ; proboscis black. Thorax dark brown with several scattered whitish scales giving, under the hand-lens, the appearance of a fairly distinct broad median pale line ; there are also pale areas laterally. On the anterior portion may also be seen *four silvery white spots*, two on each side and somewhat widely separated. Scutellum white ; pleuræ with patches of white. Abdomen deep black, with white bands on the bases of the segments. Legs black ; the femora with a white spot at the apex and a distinct white ring a short distance from it, rather pale ventrally. The tibiæ of the fore and mid legs with a somewhat indistinct white band towards the basal half, *those of the hind pair with a very marked band near the centre* *. The tarsi of the first two pairs with three narrow white bands, those of the last pair with five broad bands, the last joint being all white.

Wings with the veins darkly scaled, the first fork cell being longer than the second, their bases being almost level.

Length 4–5·5 mm.

Stegomyia (**Kingia**) **africana**, Theobald.

Characters as seen under a lens, × 16 :—Head black, with a yellowish spot in the middle ; proboscis black ; palpi black, with the tips white. Thorax black, with *two short glittering lines* directed upwards on the anterior part, and a similar small spot at the base of each wing ; scutellum white ; pleuræ

* According to Theobald (Mon. Culicid. i, p. 301) this tibial band is not present in all specimens.

with several silvery spots. Abdomen dark brown, unbanded, with pale rather indistinct lateral spots on some of the last segments. The last segment with two bright metallic spots: venter with bands of the same metallic appearance as those on the thorax. Legs black, femora with metallic white patches on the inner surface; tibiæ of the first two pairs of legs black, of the hind pair with a white basal band, narrow on the upper surface but much deeper on the ventral surface. Tarsi of the fore and mid legs with two rather indistinct white bands: hind pair with four bands, the third being very broad and the fourth narrow. The two latter are separated by a small black band.

Wings similar to those of *Stegomyia fasciata*.

Length 4–4·5 mm.

The following synopsis may also assist the student in discriminating these three species:—

	Stegomyia fasciata.	*Stegomyia sugens.*	*Stegomyia africana.*
Head.	Distinct double median and marginal lines.	Indistinct white median line and lateral white patches.	Yellowish spot in centre.
Thorax.	Dark brown, with two narrow yellowish-white parallel median lines and two silvery lateral curved lines (lyre-pattern).	Dark brown, with four silvery-white spots on the anterior part and pale areas due to scattered silvery scales.	Black, with two short white metallic lines directed upwards on the anterior portion and a spot of similar appearance at the base of each wing.
Abdomen.	Dark, with white basal bands and lateral spots.	Dark brown, with white basal bands and lateral spots.	Dark, *unbanded*, with pale rather indistinct lateral spots on some of the last segments. The last segment with two bright metallic spots.
Legs.	Femora often with a distinct white line continuing from the base almost to the apex; white apical spot; pale ventrally. Tibiæ black. Tarsi of fore and mid pairs of legs with two white bands; hind pair with five bands, the last joint being all white.	Femora with a white ring near the apex and a white apical spot; scattered white scales ventrally. Tibiæ with a white band near the middle, more distinct in the hind pair. Tarsi of fore and mid pairs of legs with three narrow white bands; hind pair with five broad bands*, last joint all white.	Femora with metallic patches on the inner surface. Tibiæ of fore and mid legs black, of hind pair with a white basal band much broader on the ventral surface Tarsi of fore and mid pairs with two indistinct white bands; hind pair with four bands, the third very broad and the fourth very small.

* These are deeper than those in *Steg. fasciata.*

VI. Characteristics of the Egg and Adult Larva of *Stegomyia fasciata*.

The Egg.—This is very elongate, blackish in colour and rather sparsely studded with minute hemispherical bodies of whitish secretionary matter.

The Larva.—One of the marked habits of the larva is that it occasionally swims and wriggles along the surface of the water like the larvæ of certain Anophelines. It has been shown (see p. 246) that it is capable of remaining

Larva of *Stegomyia fasciata*.

submerged for relatively longer periods than is commonly the case among the larvæ of numerous other Culicines.

The siphon is about one fourth of the entire length of the abdomen and about two and one half times longer than the width at the base. This character is, however, not altogether reliable, as the larvæ of other Culicines possess siphon tubes of similar dimensions.

The distinguishing morphological characters, which can only be determined by the aid of the microscope, are as follows :—

Antennæ smooth, the tuft being represented by a single short hair ; at the apex there is a minute but distinct second joint and a few very delicate hairs (figs. 1 and 2, p. 244). The labial plate possesses 11–12 teeth on each side and a larger median one ; the base is also symmetrically crenulated as shown (fig. 3). The thorax is rather hairy, some of the hairs arising from four distinct chitinous hooks (fig. 4), situated two on each side of the thorax. On the 8th segment of the abdomen are the lateral combs, each of these is composed of from 8–10 serrated spines varying in form and also in the

number of serrations (figs. 5 and 6). The siphon or pecten spines (figs. 7 and 8) are variable in form and number, there being in the specimen under observation twelve; immediately following these is a triple hair. The last segment is very short, being almost rectangular and bears a number of bifurcated hairs * (fig. 9): the papillæ are stout, about $1\frac{1}{2}$ times the length of the segment and with rounded ends.

H. F. Carter ad nat. del.

Characteristics of the larva of *Stegomyia fasciata*.

1. Apex of antenna.
2. Antenna, showing the tuft, composed of a single hair.
3. Labial plate.
4. Thoracic hook.
5. Serrated spine from centre of lateral comb.
6. Serrated spine from side of lateral comb.
7. Pecten spine from base of siphon.
8. Pecten spine, situated near the apex of the siphon.
9. Bifurcated hair from the ninth abdominal segment.

VII. On the Life-Cycle and Larval Habits of the *Stegomyia*.

Period of the Life-Cycle.

For information on this subject we have to rely chiefly upon the evidence which has been adduced by Goeldi ('Os Mosquitos no Pará'). It must be noted, however, that climatic conditions have a marked influence on the

* These are not simple as stated and figured by Wesché (Bull. Entom. Research, April 1910, p. 25).

developmental cycle of this insect in any given locality, and it may be taken as a general rule that cold will retard any one of the stages either of the ova, larvæ or pupæ ; while a rise in temperature will so shorten the cycle as to bring it within the shortest period possible.

The Egg.—Under normal conditions the incubation period, in the Amazon region, has been found to vary from 3 to 8 days ; the average, however, may be taken as 3–4 days.

Larval Stage.—The minimum period as given by Francis (Publ. Health & Mar. Hosp. Serv. Rep. xxii, 1907, p. 382), in water kept at an even temperature of 80° F., was 7 days. In Newstead's record (Journ. Trop. Med. & Paras. Liverpool, iv, p. 143), 9 days are given and the temperature that of 23° C. (=73·4° F.). Mitchell * states that the larval stage extends over a period of from 8–13 days "in fairly warm weather."

Pupal Stage.—The duration of this stage varies from 1–5 days. Mitchell (*l. c.*) gives 1–5 days ; Newstead 2–3 days in a temperature of 23° C.

Adults.—The female lays her eggs in from 6–15 days after taking the first meal of blood, but Mitchell (*l. c.* p. 148) states that the female may feed two or three times before laying the first batch of eggs. The average number of separate batches of eggs laid by a single female may be given as 2–3 ; but as many as nine batches have been laid in some cases.

The eggs are extruded singly, and the number laid on each occasion varies from 27–97. Goeldi † found that as a rule the females died immediately after the final act of parturition, though in two instances females survived for 12 and 14 days respectively. He also states that fertilized ova may lie latent in the body of the parent for from 23–102 days, and that the female may lay her eggs at the end of these periods, respectively, after taking a meal of blood. It is evident therefore that ovulation is retarded until suitable food is obtained.

It is generally held that the females feed almost exclusively upon warm-blooded vertebrates, and it is usually supposed that such food is necessary for the development of fertile eggs. Goeldi succeeded however in inducing females to feed upon honey, a diet upon which they survived for periods varying from 31 days to, in one instance, 102 days, though it is evident that such food has a retarding or neutral effect upon ovulation.

Males of *Stegomyia fasciata* also survived on honey for periods varying from 28 to 72 days.

These important data point to the fact that in a state of nature both sexes may, as occasion serves, feed upon the nectar of flowers, though one has failed to find, in the innumerable publications which have been issued regarding the habits of this insect, any evidence that this actually takes place under natural conditions.

* 'Mosquito Life,' p. 148, 1907.

† 'Os Mosquitos no Pará.'

Food of the Larvæ.

So far as one can gather there is no evidence as to the exact nature of the food of the larvæ. In captivity they feed largely upon amorphous matter and upon the macerated remains of minute crustaceans (*Cyclops* sp., *Diaptomus* sp., etc.), minute fragments of aquatic plants, an occasional diatom and unicellular plants.

The larvæ of *Stegomyia fasciata* have been found in association with those of several other species of mosquitos, notably with those of *Culex fatigans* and to a less extent with *Limatus durhami*, etc. Dupree has made some interesting discoveries regarding the habits of the larvæ, which are communicated by Mitchell in her excellent memoir (*l. c.* p. 147). It is stated that the young larvæ are remarkably tenacious of life under water: they tolerated as much as three hours submergence and in some cases were resuscitated after five hours; on the other hand, adult larvæ tolerated total immersion for 1½ to 2 hours. This habit enables them to feed at the bottom of cisterns of normal depth and to remain submerged for unusually long periods.

Resistance to Frost.

There is apparently no direct evidence to prove that the larvæ of *Stegomyia fasciata* can survive at a temperature of freezing point, though they have been found by Francis (*l. c.*) at Mobile, Ala., U.S.A., living in tubs placed in sheltered positions during frosty weather and when the water in vessels exposed to the open air was coated with ice half an inch thick. But it is noteworthy that some large healthy larvæ, which were found in the living-room of a hospital, died when placed in an ice-box where the temperature was about 50°. It is quite evident, however, that this insect can survive at a relatively low temperature, as may be gathered from the statements given by Mitchell *, who says that larvæ were found by her in November at Baton Rouge at a temperature as low as 34° F., and further that pupation took place in water at 53° F. Cold "stiffens" the adults, but one was observed by her to revive afterwards.

VIII. Viability of the Ova after long Exposure to Dry Atmospheric Conditions.

Mr. F. V. Theobald † was apparently the first to discover that the eggs of this mosquito will remain fertile for a long period, although exposed to normally dry atmospheric conditions. In this instance the eggs were forwarded to England from Cuba in a perfectly dry test tube. After a period of two months they were placed in "tepid water" and the majority of them produced larvæ. Many of these larvæ survived until the tenth day.

* 'Mosquito Life,' p. 148, 1907.

† Mon. Culicidæ, vol. iii. p. 143.

and six of them pupated at the end of three weeks, one of which gave rise to a perfectly well-formed female. Unfortunately no details are given as to the temperature in which this experiment was conducted; but it is important to note that the insects were reared in a greenhouse,

Newstead * has conducted similar experiments with eggs of this mosquito from material forwarded from Manaos by Dr. H. Wolferstan Thomas in the year 1906. The eggs were laid on moist white filter-paper; these were dried in the air and subsequently placed in a desiccator with chloride of calcium for 24 hours, and finally transmitted to England in glass tubes, tightly corked. The following data indicate the results of this experiment :—

September 9–11.	Eggs laid at Manaos, Amazon.
October 26.	Eggs reached England. Placed in water at a temperature of 23° C. (=73·4° F.).
„ 27.	12 larvæ hatched during the previous night and one after twelve hours immersion.
„ 28.	Larvæ began moulting.
„ 30.	All larvæ completed first moult.
November 4.	Larvæ pupated.
„ 7.	First imago, a male, hatched. This example lived for 6 days.
„ 8.	A male and female hatched.

The breeding-jar was kept in an incubator at an even temperature of 23° C. For the greater part of the time the insects were in complete darkness; but a little light was admitted occasionally during the day.

Summary.

Eggs remained dormant and practically dry 45–47 days.

Life-cycle.

Eggs. Incubation period	6–12 hours.
Larval stage	9 days.
Pupal stage	3 days.
Complete cycle	12–13 days.

From these data it will be seen that the life-cycle was completed as rapidly as the minimum period given by Goeldi † in his classical memoir on the Mosquitos of Pará. This is all the more remarkable seeing that the larvæ and pupæ were *kept in almost total darkness* and also in a highly vitiated atmosphere. Subsequent experiments have proved, however, that eggs kept

* Journ. Trop. Med. & Parasitology, Liverpool, vol. iv. p. 143.

† 'Os Mosquitos no Pará,' p. 6.

for a longer period than two years lose their vitality and become completely desiccated. Surgeon Francis * has also shown that eggs "may remain viable for six and one-half months when kept dry." It should be noted, however, that in this instance the eggs were not artificially dried, as was the case with those which were forwarded to Liverpool from Manaos, but were allowed to remain attached to the sides of the jar in which they were laid, above the level of the water, and "set aside in a wardrobe in a room which had no fire in it all winter and the doors and windows were open night and day." The temperature in which these eggs were kept is omitted also in this case. At the end of the period stated above, eggs placed in a temperature of 80° F. produced larvæ in seventeen hours, and adults nine days later. After taking a meal of blood the adults laid eggs which proved fertile, producing about 100 larvæ six days after the parent insects had emerged from the pupæ. The complete cycle in this case was shorter, by about two days, than that obtained by Goeldi in a tropical climate and apparently under normal conditions.

Peryassú † has also succeeded in rearing larvæ from eggs which had been exposed to dry atmospheric conditions for a period of five months; and adds that "this was the maximum time they resisted, and after this they did not hatch."

Boyce brought specimens of larvæ alive to Liverpool which were collected in Puerto Barrios in Guatemala on October 26th. They were kept in a test-tube exposed to the great variations of temperature which occurred in travelling from Guatemala to New Orleans, New Orleans *viâ* Washington to New York, and then across the Atlantic to Liverpool. The journey occupied 25 days ‡.

IX. Distribution of the *Stegomyia* in Africa.

Stegomyia fasciata, according to Otto & Neumann, has been long known in Senegambia, Sierra Leone and the Slave Coast, and in other parts of the West Coast of Africa. There can be no doubt that the species has been present certainly through the 18th and 19th centuries, that is to say during the period of recorded outbreaks of yellow fever. Whether it was originally introduced into the West Coast, or whether, like other mosquitos, it is an original native of the Coast, it is quite impossible to be certain, seeing that we know so little of the early history of insect life. We do know, however, that the *Stegomyia* could readily have been introduced by any ship, from the 16th to the 20th century, trading between yellow fever countries and West

* Public Health & Mar. Hosp. Serv. Rep. no. 14, vol. xxii, 1907.

† 'Os Culicideos do Brazil,' p. 373, 1908.

‡ Yellow Fever Prophylaxis in New Orleans, 1905, Memoir xix. Liverpool School of Tropical Medicine.

Africa. But the reverse could equally well have taken place, and indeed some authorities, Goeldi for example, regard the West Coast as an original home of the *Stegomyia*. But whatever its origin, it has been long an inhabitant of the West Coast. Evidence is in favour of its having greatly multiplied during the 18th and 19th centuries, that is to say, during the period of the opening up of the Coast of Africa to Western civilisation. As soon as towns increased in size and new ones sprung into existence, the *Stegomyia* was given enormously increased opportunities for breeding, as compared with the primitive periods. No doubt the mosquito, like yellow fever itself, increased with commercial development until comparatively recently, when, thanks to scientific research, steps were taken to wage war on the breeding places. We know that the mosquito is present in Togoland, Dahomey, Nigeria, Gold Coast, the Cameroons, Sierra Leone, Gambia and Senegal. It has also been recorded, so it is stated, from German and British East Africa, and in Durban.

In 1901 Major Ross, and in 1904 Dr. Prout, drew attention to the prevalence of *Stegomyia* in Freetown. The late Dr. Dutton pointed out in 1902 that this mosquito was the species most commonly met with in Bathurst. From recent observations carried out by Graham and others, there is no doubt that *Stegomyia fasciata* is today the common mosquito of the Coast towns.

As yellow fever has again this year (1910) declared itself both on the Gold Coast and in Sierra Leone, it is now a necessity, before it is too late, to take steps to ascertain accurately the prevalence and distribution of this pest all over Africa. Yellow fever has penetrated to the Sudan, and it may spread to the East Coast and North of Africa, if not already there in an endemic form.

I. The Stegomyia in Sierra Leone.

Freetown.

In 1901, Ross pointed out the prevalence of *Stegomyia fasciata* and organised mosquito brigades to do away with it and other mosquitos. Dr. Prout also drew attention to its prevalence.

This year, 1910, careful surveys have been made both by myself and Dr. Kennen and his assistants, with the following results.

In the month of August 1910, I made, with Dr. Kennen, the Senior Sanitary Officer, a house to house investigation of Freetown and covered altogether 200 houses with their yards and out-houses.

The streets selected were representative of the various classes in Freetown, including the merchants' quarters, those of the small traders and Syrians, and the native residential quarters of the well-to-do and the poorest. The 200 houses and yards contained 87 barrels, 144 buckets, 50 earthenware pots, 66 tin cans, 17 stone jars, 121 odd receptacles and 27 wells. Therefore, distributed amongst the 200 houses there were no less than

500 receptacles capable of holding water, and in most instances water was present. Larvæ were found in 88 houses, distributed amongst 174 receptacles out of the 500 potential water-containers ; reckoning, however, that 88 houses out of 200 were found harbouring larvæ, the percentage works out as 44 per cent. The streets examined by me were Circular Road, Regent and Goodrich Streets, Wilberforce Street, Fourah Bay Road, Howe Street, Charlotte Street, Little East Street, Charles Street and Kissy Street.

When I made my inspection of Freetown several previous cleanings up of the town had already been made, and innumerable odds and ends removed. Moreover, as there is a pipe-borne water supply the necessity for barrels and water receptacles is greatly diminished. Nevertheless, as the survey shows, there were yet numbers of unnecessary water-containers and wells which are worse than useless. The larvæ were in almost all cases those of the *Stegomyia* ; whenever I was in doubt, I took samples to my office to hatch out. Mr. Newstead, to whom I brought back the adults for corroboration, informs me that the 129 specimens were all *Stegomyia fasciata*, with the exception of two specimens of *Culex pruinosus*. After examining another series of adult mosquitos bred by Dr. J. G. Wood, of Freetown, from larvæ collected in odd receptacles, Mr. Newstead reports as follows :—

Kroobay, Freetown, in rock pool, 31.viii.10 :—
3 specimens of *Stegomyia sugens*, Wied.
Pulteney Street, Freetown, in cask, 25.viii.10 :—
2 specimens of *Stegomyia fasciata*, Fab.
Vals Showrooms, Water Street, Freetown, 27.viii.10, in old tank :—
3 *Stegomyia fasciata*, Fab.
Dundas Street, Freetown, in tin and rock pool, 24.viii.10 :—
3 *Stegomyia fasciata*, Fab.
George Street, off Upper Brook Street, 14.viii.10 :—
1 specimen destroyed, 1 *Stegomyia fasciata*.
Percival Street, in tin, 25.viii.10 :—
2 *Stegomyia fasciata*, Fab., 2 specimens destroyed.
Waterloo Street, in foul tin, 26.viii.10 :—
3 *Stegomyia fasciata*, Fab.

As the result of the examination of a third series sent by Dr. J. G. Wood, Mr. Newstead reports :—

John Lane, Freetown, outskirts, in pool, 9.ix.10 :—
3 *Culex invenustus*, Theo.
Fergusson Street, Freetown, in rock pool, 7.ix.10 :—
1 *Pyretophorus costalis*, Loew.
Ascension Town, Freetown, in pot, 10.ix.10 :—
1 *Stegomyia africana*, Theo.

Kroobay, Freetown, in canoe, 31.viii.10 :—
1 *Culex* sp. ?, badly damaged.
Deborah Street, Freetown, in cask, 6.ix.10 :—
1 *Stegomyia fasciata*, Fab.
Soldier Street, Freetown, in old pot, 15.ix.10 :—
1 *Stegomyia fasciata.*
Adelaide Street, Freetown, in lily pot, 3.ix.10 :—
1 ♂ *Stegomyia sugens*, 1 badly damaged *Culex* sp. ?
Vals Showrooms, Water Street, Freetown, in old tank, 29.viii.10 :—
2 *Stegomyia fasciata*, 2 *Stegomyia sugens.*
Benjamin Lane, Freetown, in cask, 9.ix.10 :—
3 *Stegomyia fasciata.*

The above data sufficiently indicate that *Stegomyia fasciata* is by far the most prevalent mosquito found in artificial collections of stagnant water. The reports show that in the course of a few weeks the percentage of houses infested has been reduced from 44 per cent. to 7 per cent., and that it is possible without any large expenditure of money to reduce it still further.

Sierra Leone Protectorate.

I was enabled to examine both Bo and Kenema, which are towns in the interior on the railroad. At Bo, in the native town, I found the common mosquito to be *Stegomyia fasciata* ; it was breeding in barrels and in all collections of stagnant water retained in cans, bottles, or odds and ends.

In Kenema, which is a wonderfully clean native town, there is a pipe supply of water, and there are few barrels or odds and ends. I found *Stegomyia* however in a large rot-hole in a tree and in a barrel used by builders.

Bullom Country.

After making a sanitary tour of inspection of this part of Sierra Leone in February 1909, the Medical Officer in charge reported :—

"*Stegomyia fasciata* swarms in the grass fields and is also common in the coast towns ; this being so, if yellow fever once got a hold of the country, it would spread rapidly right up to Port Lokko, if not further."

There can be no doubt that the common mosquito breeding in artificial water-containers in Freetown is *Stegomyia fasciata.* This finding is in conformity with what we know of yellow fever in the Colony, and supports the view that the disease is endemic.

2. The Stegomyia in the Gold Coast Colony.

On my arrival in June 1910 in the Gold Coast Colony, I immediately set to work to obtain an estimate of the prevalence and numbers of *Stegomyia* in

Sekondi, and at the same time I addressed a circular letter to Medical Officers throughout the Colony asking for information under the following heads :—

1. A return showing the number of houses and yards in which *Stegomyia* have been found.
2. The nature and approximate number of water-holding receptacles in each house.
3. Any reports or traditions of cases of Yellow Fever in the Port.
4. The nature and extent of any anti-larval measures which may have been carried out, such as, removal of odd receptacles, screening water-containers, oiling, bush-clearing, draining or fish-stocking.

Previous to my arrival, the Senior Sanitary Officer had instituted a vigorous removal of all larva-breeding receptacles from the yards, and the screening of all large water-containers. He estimated that, at the commencement of operations, in all probability every house was breeding larvæ ; that in other words, the *Stegomyia* index was 100 per cent.

On my arrival I went through the town with the Senior Sanitary Officer, and the assistant medical officers, and a house to house inspection yielded the following results :—

842 houses were examined, and larvæ were met with in 162; yielding therefore an index corresponding to 23 per cent.

The following are the figures :—

House to House Inspection of the town of Sekondi, from the 29th of June to the 4th July, 1910.

	Houses visited.	Larvæ found.	Percentage.
Sekondi Town .... (Dr. Muggliston)	267	29	19
Esikadu ..... (Dr. Fraser)	135	49	37
Lago Side ..... (Dr. Croley & Dr. Goodbrand)	376	86	22
Business Area	64	1	1·55

Stegomyia survey of Accra.

On the 7th July, 1910, the Principal Medical Officer reported :—

Number of houses inspected, 729.

Number of houses where larvæ or imagines of *Stegomyia* were found, 477.

In conjunction with Drs. Garland, Rice and Beamish, I myself made a house to house inspection, and although the inspectors had already been

through the town, nevertheless I found a vast number of breeding places. I examined 80 houses. In these I found 404 receptacles of all kinds containing water; earthenware pots were most abundant. Of the 80 houses, larvæ were found in 61; the number of infested receptacles being 138. I hatched out many of the larvæ, and Dr. Graham confirmed my diagnosis of *Stegomyia fasciata*. In addition to finding very large quantities of empty tin cans, it was noted that there was an excess of bush all over the town, which might effectively conceal other such tins and prevent the water in them from evaporating.

Cape Coast Castle, July 1910.

The report of the Medical Officer states that "out of 15 European bungalows examined larvæ were found in 13.... Larvæ were found in all native houses without exception."

In a hurried examination which I made with the Medical Officer on the 6th July, I found a very bad state of affairs. In 30 houses, or their yards, there were 32 earthen pots, 18 barrels and 3 wells, and larvæ were found in 17 of the 30 houses (index 57 per cent.). The *Stegomyia* was the prevailing species.

Axim.

The Medical Officer reported that he had personally inspected 63 houses and found larvæ in 6, in every instance they were those of the *Stegomyia*; index 9 per cent. Another report stated that 1,136 houses had been inspected and in 50 larvæ were found; index 4 per cent.

Elmina.

The report of the Medical Officer gave the *Stegomyia* index as 33 per cent.

Saltpond.

The report of the Medical Officer stated that 275 houses had been examined and larvæ found in 78; index 28 per cent.

Kitta.

The Medical Officer reported the *Stegomyia* present in all houses; index 100 per cent.

Adaa.

The Medical Officer estimated the percentage of *Stegomyia* as 6 per cent. In an examination of houses which he made he was unable to detect the *Stegomyia* amongst the larvæ.

Tarkwa.

The Medical Officer reported the index as 10 per cent. He also stated that of 136 rooms inspected, in 14 the larvæ or the imagines of the *Stegomyia* were found. On the 24th June I visited the town, and in an examination of 40 houses in the miners' village I found *Stegomyia* larvæ in 23. In my opinion the prevailing mosquito in Tarkwa is *Stegomyia fasciata*.

Obuassi.

I inspected 100 houses in this district and found 191 receptacles. Larvæ of the *Stegomyia* were found in 55 of the houses; index 55 per cent.

Kumasi.

The Medical Officer reported that in an examination of 520 houses larvæ were found in 48; index 9 per cent. On the 2nd July I myself made an examination of the 48 houses and found the larvæ of the *Stegomyia* breeding in 8.

3. The Stegomyia in Senegal, Ivory Coast and Dahomey.

Bouffard pointed out the prevalence of the *Stegomyia* in the Upper Senegal and French Niger territory in 1906. Ribot and Le Moal also drew attention to the widespread distribution of this species in Senegal, and describe the various anti-Stegomyia measures. From the history of yellow fever in that country, it is evident that this must be the prevailing mosquito of the towns, and that it is widely distributed, reaching as far as Dioubeba in the Sudan. In a more recent paper Bouffard draws attention to the essentially endemic character of yellow fever throughout Senegal. He has investigated the trade routes, both by road, rail and water, between Koulikaro and Timbuktu, Bamako and Sikasso, Segu and San, and between Segu and Kutiala, and finds the *Stegomyia* in all centres of population. This observer insists on the essentially domestic character of the mosquito, and that it is not as a rule found beyond a radius of 100 metres from the dwelling houses. Le Moal gives the distance as 250 metres. He concludes that the mosquito is abundantly distributed throughout all the towns and villages, and that it breeds in the various receptacles which I have already described, and also in all puddles near houses after rain. For the safety of the white man, he insists upon segregation and anti-larval measures. Le Moal describes the *Stegomyia* as abundant throughout Senegal, especially at St. Louis and Gorée Island, also in Konakry, and at Grand Bassam on the Ivory Coast.

4. The Stegomyia in German African Colonies.

According to Otto and Neumann, the mosquito is present in Togoland, Cameroons, and in German and British East Africa (Ollwig). It is still doubtful whether it is present in German South-West Africa.

The German authorities are fully alive to its significance, and have introduced strict anti-stagnant water ordinances for Togo, in 1910. Much more accurate information is still wanted as regards its distribution and prevalence in the West and East African Colonies, and it is to be hoped that definite information will soon be forthcoming.

5. The Stegomyia in Southern Nigeria.

In company with Drs. Pickles, Laurie and Tynan, of Lagos, I made a thorough house to house inspection of 100 houses, selected in representative parts of Lagos, including the poorest, lower middle class and white trading classes. The houses in the poorest part of the town are veritable rat-traps, dovetailed into one another, and abominably overcrowded for the amount of ground space ; they are in consequence very dark, and in the course of all my experiences I have never yet found so many receptacles of all kinds containing stagnant water, or containing such an immense number of *Stegomyia* larvæ. Altogether in the 100 houses and yards there were 489 collections of stagnant water ; these consisted of 339 earthen pots, 32 wells, and the remainder of buckets, barrels, and odds and ends. Earthenware pots, therefore, vastly predominated over all other water receptacles. I found larvæ in 252 receptacles ; and as the houses are packed closely together, I am of opinion that it is understating the percentage if it is placed at 100 per cent., for unquestionably each house was infested with *Stegomyia*, breeding in its own yard or room, or in the adjacent yard or hut. Speciments of adult *Stegomyia* were present in the houses in far greater numbers than I have seen them in any other part of the Tropical World. The larvæ were in the vast majority of cases those of *Stegomyia fasciata*. To make sure, however, I bred out numerous batches, which were submitted to Dr. Graham, who confirmed my diagnosis, and also found *Culex tigripes*, *Culex hirsutipalpis* and *Culex albovirgatus*, Graham. Dr. Graham had already drawn attention to the prevalence of the *Stegomyia*, and its danger from the point of view of yellow fever. He regards this mosquito as the common species of the Coast towns.

From the reports made by the Sanitary Inspectors and furnished to me by Dr. Tynan, there is no doubt that *Stegomyia fasciata* is the common mosquito of Lagos, and is breeding in immense numbers in that town. In the Central Province of Southern Nigeria, Dr. MacDonald considers it to be the commonest mosquito found breeding in water-containers. From a report furnished by the Medical Officer of Sapele, the *Stegomyia* index in that locality is 13 per cent. The Medical Officer at Warri reports that before cleaning-up operations mosquito larvæ were present in every compound. The Medical Officer at Forcados reports the *Stegomyia* index as being 2 per cent. The Senior Medical Officer of the Eastern Province (including Bonny and Calabar) reported in July 1910 that every native house and compound contained water receptacles, and the larvæ usually present were those of *Stegomyia fasciata*. The Medical Officer at Opobo also draws attention in a report to the universal distribution of the *Stegomyia* in Southern Nigeria and the danger arising from this fact, were yellow fever introduced.

In conclusion we may reasonably assume that, as in Lagos, the prevailing house mosquito of the towns in Southern Nigeria is *Stegomyia fasciata*.

This species has also been found at Brass, Akassa and Bonny by Mr. J. J. Simpson, and at Degema by Mr. A. H. Hamley *.

During this year, 1910, increased energy has been shown in cleaning up the compounds, removing odd receptacles, and in screening tanks and vats; fines have also been inflicted for neglect of these precautions.

Far more systematic anti-mosquito work must be undertaken before it can be said that yellow fever is not endemic, or that there is no danger from importation.

6. **The Stegomyia in other parts of West, East and South Africa.**

Mr. Guy Marshall has furnished me with the following list of additional places where *Stegomyia fasciata* has been reported †:—

Northern Angola: San Salvador (*Dr. Mercier Gamble*).

The island of Principe (*Dr. Ansorge*).

British Somaliland: Zeila (*Dr. A. J. M. Paget*), Bulhar (*R. E. Drake-Brockman*).

British East Africa: Mombasa (*J. D. McKay*).

Nyasaland: Zomba (*Dr. H. S. Stannus*) and Blantyre (*Dr. J. E. S. Old*).

Natal: Durban (*Dr. Christophers*).

No information, however, is forthcoming as regards the distribution and abundance of the insect. It is to be hoped that careful reports will be drawn up upon these important points.

X. Destruction of *Stegomyia fasciata*.

In the preceding pages I have sketched the wide distribution of the *Stegomyia* in West Africa, and its significance is obvious, for it explains why, for the last 100 years at least, yellow fever has been common on the Coast. It explains the outbreaks of yellow fever for this year (1910), and it warns us that if West Africa is to be still further developed in connection with its great potential mining, oil and other industries, it will be necessary to eradicate the *Stegomyia* or face the certainty of the disaster and panic which will ensue from outbreaks of yellow fever.

The existence which I have endeavoured to show of the *Stegomyia* in overwhelming preponderance in the Coast towns and in many of the interior towns of West Africa also goes far, in my opinion, to explain the very high mortality rate amongst Europeans in the past. This high death-rate has as a rule been attributed to malaria, in one or other of its many forms. But

* [The following additional localities for the species in Southern Nigeria have been noted since the above was written:—Ikot-ekpene (*J. J. Simpson*, 3 specimens), Buruttu (*J. J. Simpson*, 6 specimens), Oshogbo (*Dr. T. J. F. Mayer*, 7 specimens, in house) and Ilesha (*Dr. T. J. F. Mayer*, 2 specimens, in house). The following specimens have been received from Northern Nigeria, collected by Mr. Simpson: 6 from Lokoja and one from Baro.—Ed.]

† [These records are based on specimens contained in the British Museum collection or received by the Entomological Research Committee. Mr. McKay notes that at Mombasa this mosquito is common and troublesome.—Ed.]

I think, not only from the evidence of the wide distribution of the *Stegomyia*, but also from the evidence of Hospital Case Books and the experience of English, French and German medical authorities, that a very considerable proportion of the death-rate may, with a high degree of probability, be ascribed to yellow fever ; that, in fact, the disease has been often overlooked. In other words, when the yellow fever cases are taken out, the malaria death-rate on the Coast is not unlike the malaria death-rate of all other malarial countries ; and it seems probable that the deadly reputation of West Africa has to a large extent been due to mistaken diagnosis, to neglect of fumigation after cases of yellow fever, and above all, to the absence of any attempt to reduce the vast numbers of the *Stegomyia*. Therefore, if West African development is to proceed in security, it is necessary to lose no time in organising methods to combat this mosquito.

I arrange these measures as follows :—

Measure I.

The first step is to organise the medical and sanitary forces, and also citizen volunteers, to make a systematic raid on all breeding places, as follows :—

1. The removal and burial of all tins, bottles, calabashes, broken crocks, etc., capable of holding water.
2. The clearing of all bush from yards and waste places, and from the immediate vicinity of towns and villages.
3. The setting apart in all towns of regular cleaning-up days, when all the inhabitants should be urged to assist in getting rid of water-holding rubbish.
4. The institution of popular lectures ; the instruction to school children ; the exhibition of diagrams and notices in all public places ; and the co-operation of ministers of religion and all public bodies in the great work of exterminating the *Stegomyia* pest.

If action is taken under the above heads a great deal can be accomplished at a comparatively small expense. But for its success, it means that, to commence with, the medical officers will require themselves to set an example in the matter of cleaning up, and that they will have to act as sanitary inspectors and labourers. It will also mean that more sanitary inspectors will require to be trained, and that more refuse carts will have to be obtained. Above all, it means that the work must be sustained and not spasmodic, in two or three weeks everything tends to relapse into the *status quo ante* and the bush is as bad as ever. Therefore, provision must be made for regular daily cleaning-up work and inspection.

Measure II.

The next point is to abolish or screen all accumulations of stagnant water ;

and it is now a common practice to enact and put in force anti-stagnant water ordinances in all countries liable to yellow fever. They have in practice been found to work admirably and to cause no ill-feeling. At first, of course, there is liable to be some opposition, but that soon dies out, and the wisdom of the precautions becomes generally recognised, provided the laws are properly enforced; any weakness in this respect being fatal, as also any great delay in punishing offenders. In other words, magistrates should be expected to co-operate with the sanitary authority in a matter of such vital importance to the health and welfare of the community. If this is not done, then the medical officers, sanitary inspectors and others co-operating lose heart and tend to become slack.

In framing anti-larval measures, it must be remembered that the object is to prevent the keeping of stagnant water *in any receptacle*, whether tins, barrels, crocks, cisterns, etc., and the presence of larvæ must be taken as proof of stagnant water.

Measure III.

It has been found all over tropical and subtropical America and the West Indies, that the reform which strikes at the root not only of yellow fever, but of a great number of other diseases also, is the introduction of a pipe-borne water supply. This system does away with the necessity of storage-barrels, cisterns and wells. Therefore, it is to be hoped that in all West African towns the first opportunity will be taken to institute a healthy water-supply.

Some towns have already commenced this most useful reform. If, however, delay is inevitable, then the legitimate water-storage vessels must be protected in an efficient manner from the *Stegomyia*. Cisterns and barrels should be made of a uniform pattern and should be wire-screened in a proper manner, according to the designs of the Health Board. Wells should be filled in, unless absolutely necessary, or kept regularly oiled. They are a terrible source of danger, and more especially in the mining districts to which immigrants from other parts of Africa and Europe are being attracted, and where, in consequence, cholera may at any time gain a footing. The sooner, therefore, wells are abolished, the better for the health of West Africa. In the native towns, the earthen vessels will offer a considerable difficulty; some endeavour must therefore be made to offer the inhabitants, at a cheap rate, a standard form of barrel or cistern.

In the above described three measures, there is nothing insurmountable or very costly. In the first place, the work of cleaning up can be started at once; next, the screening and oiling of all large water receptacles; and thirdly, the introduction of proper water-supplies. These measures follow one another in natural sequence, and pave the way for one another.

Measure IV.

Another measure of great economic importance to the welfare of the community is the filling in of swamp land and general drainage. Not only does a measure of this kind affect the general health, and the breeding of mosquitos, but it is a work of great commercial advantage, for it reclaims land. Already in Southern Nigeria a great step in this direction has been made by the employment of the sand-pump to fill in swamps.

The drainage of the town should be early planned out, and then carried out from time to time as funds will allow.

Culicides for the destruction of Larvæ.

The most economical, least dangerous, and most readily procured of all culicides, are the various preparations of petroleum. This oil can be used on a large or small scale, and it can be either sprayed or poured on the water. For all stagnant collections of water in pools or lagoons it is excellent, and its culicide action remains long after such collections of water have been treated. It must be recollected that under a powerful tropical sun the oil evaporates in a comparatively short period, and that therefore the treatment must be renewed every few days. I made some experiments this year in order to determine how soon the effect of the oil passed off. My experiments consisted in placing in a large tub of water, of one square yard superficial measurement, a number of the larvæ of the *Stegomyia*. Then I poured on to the surface one ounce of kerosene oil, and exposed the tub either in the bright sunshine, or kept it under shade. I timed the starting of the experiment, and the time when the larvæ ceased to move.

Experiment I.

Surface covered with one ounce of oil and exposed to powerful sun.

Stegomyia larvæ placed in water at 12 noon ; at 3 P.M. all larvæ dead, and most of the oil evaporated.

Experiment II.

To determine rate of evaporation. At the end of 3 hours the oil had evaporated, leaving but a faint smell and producing only a slight oil stain on blotting-paper.

Experiment III.

Half an ounce of oil poured on the water. Larvæ placed in the water at 12.30 P.M., and all dead at 1.30 P.M. ; at 5.25 P.M. the oil had evaporated with the exception of a faint odour and very slight iridescence. I then placed fresh *Stegomyia* larvæ in the tub without adding any additional oil, and at 6.30 the larvæ were dead. It appears that the small quantity of dissolved oil has a culicide action.

Experiment IV.

Half an ounce of oil poured on to the surface of water in the tub, and larvæ placed in the water at 1.40 P.M. in bright sunshine ; at 3.15 P.M. the larvæ were very sluggish but still alive ; the petroleum had evaporated from the surface.

These few experiments show that in bright sunshine the oil film rapidly evaporates, but that the oil which remains in solution still continues to exert a culicide action. Therefore it may be concluded that one ounce of oil to the square superficial yard is sufficient to kill mosquito larvæ, but that the water should be treated once a week in order to avoid all risk of the survival of larvæ.

Action of Culicides on the Adult Mosquitos.

In my experience, the best, cheapest and most readily procurable culicide is sulphur, whether used in a small way by burning in sulphur pots, or on a large scale by generating it in a Clayton sulphur apparatus. I always recommend testing the efficacy of fumigation by direct experiment, rather than relying upon calculation. For this purpose I insert living *Stegomyia* in a muslin-covered box or in some place where they can be observed from outside the room or building. When they are dead I conclude that the fumigation has been successful. The following is a brief statement with regard to the three most generally useful culicides.

Sulphur.—2 lbs. to 1,000 cubic feet. The pots containing the sulphur are to be placed in pans containing one inch of water. The sulphur is to be ignited with alcohol, and care must be taken to see that it is well alight. Duration three hours. Brass work and steel goods are liable to injury, they should therefore be removed.

Pyrethrum powder.—3 lbs. to 1,000 cubic feet, applied for three hours ; and it is better that the 3 lbs. be divided amongst three pots than that all the powder be put in one pot. The pots to be placed in pans containing a little water. Pyrethrum powder is used for rooms close to any sick patients, as the fumes which might escape from sulphur fumigation are irritating. This powder is also used in cases where brass work, pianos, telephones, instruments, etc., are present.

Camphor and Carbolic Acid.—The mixture consists of equal parts camphor and crystallised carbolic acid dissolved by gentle heat. It is an exceedingly good fumigator and does not injure furniture, clothes or brass work ; the odour is pleasant and smells of camphor. A room has a refreshing smell after its use.

Four ounces are vaporised per 1,000 cubic feet for two hours. The material is placed in an open pan placed over a spirit or petroleum lamp ; white vapour is given off.

Avoid risk of setting fire to the premises by using care and foresight.

XI. Relationship of the Distribution of the *Stegomyia* to Yellow Fever.

Without *Stegomyia fasciata* there could be no yellow fever. The distribution of the *Stegomyia* in West Africa today abundantly confirms this statement; for if the *Stegomyia* map is compared with the yellow fever map of West Africa, it will be seen that they are in close agreement.

From the following tables it will be seen how widespread is the distribution of yellow fever in West African colonies, and the very large number of years in which it has made its appearance.

Towns in West Africa in which Yellow Fever has been recorded.

Freetown.	Elmina.
Bathurst.	Kitta.
Konakri.	Salt Pond.
St. Louis.	Accra.
Dakar.	Axim.
Island of Gorée.	Grand Bassam.
Bakel, Upper Senegal.	Klein Dopo.
Kayes and Dioubeba, Senegal.	Lome.
Bamako, Upper Senegal.	Anecko.
Ascension.	Grand Popo.
Boa Vista.	Porto Novo.
Fernando Po.	Kotonou.
Cape Coast Castle.	Lagos.
Sekondi.	Calabar.
Saw Mills.	

Years in which Yellow Fever has appeared in Sporadic or Epidemic Form in West Africa.

1807	1826	1844	.....	1878	1895
1809	1827	1845	1862	.....	1896
.....	1828	1846	1863	.....	1897
.....	1829	1847	1864	.....	1898
1812	1830	.....	1865	.....	1899
.....	.....	.....	1866	1883	1900
1814	.....	1850	1867	1884	1901
.....	.....	.....	1868	.....	1902
1816	.....	1852	.....	.....	1903
1817	1835	.....	.....	.....	1904
1818	1836	.....	.....	.....	1905
1819	1837	.....	1872	.....	1906
1820	1838	.....	1873	1890	.....
1821	1839	.....	.....	1891	1908
1822	1840	1858	.....	.....	1909
1823	1841	1859	.....	1893	1910
1824	1842	.....	.....	1894	
1825	.....				

NOTE.

In order that Medical Officers should have a ready means of identifying *Stegomyia* and its larvæ, I would recommend that all such Officers should be supplied with :—

1. Examples of the male and female *Stegomyia* ;
2. Examples of the allied species ;
3. Specimens of authentic larvæ.

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Graham, W. M.—'The Study of Mosquito Larvæ.' Bulletin of Entomological Research, vol. i, pt. 1, p. 51, April 1910.

[The question as to the original home of *Stegomyia fasciata*, or of the disease which it carries, is one which is of something more than academic interest. For we may resonably suppose that if so virulent a disease as yellow fever has long been prevalent in any given country, the indigenous population would, by the simple process of natural selection, either be wiped out, or gradually develop a relatively high degree of immunity. Thus it is conceivable that the existence of such immunity may possibly give us a sound clue as to the country in which the disease has been longest

Bale & Danielsson, Ltd lith.

Map of
WEST AFRICA
Shewing places in which
Yellow fever has occurred.
Scale 1/12,672,000 or 1 Inch to 200 Miles.
100 50 0 100 200 300
ATLANTIC OCEAN
UPPER SENEGAL AND NIGER
SENEGAL
FRENCH GUINEA
PORT. GUINEA
GAMBIA
LIBERIA
IVORY COAST
NORTHERN TERRITORIES
ASHANTI
GOLD COAST
TOGOLAND
DAHOMEY
NIGERIA
CAMEROONS
GULF OF GUINEA
LAKE CHAD
St Louis
Dakar
Gorée
Wekam
Bakel
Kayes
Bathurst
Bafulabe
Tukoto Br.
Kita
Bamako
Kulikora
Sinsanding
Samamkala
R. Niger
R. Senegal
Bussura
Kangaba
Bulam
Labe
Sigiri
Kankan
Konakri
Port Lokko
Freetown
SIERRA LEONE
Bo
Baiama
Beia
Kong
Sikasso
San
Barani
Kuri
Garo
Kutiala
Boromo
Timbuktu
Gao-Gao (Gogo)
Agadez
Fada N'Gurma
R. Niger
Gando
Katsina
Hadeija
Maifoni
Bauchi
Yola
Ida
Kefi
Baro
R. Benue
Lokoja
Florin
Oshogbo
Lesha
Kintampo
Coomassie
Obuassi
Bingerville
Tarkwa
Accra
Christiansborg
Cape Coast Castle
Sattpond
Chamah
Dixcove
Axim
Gr. Bassam
Adda
Akitta
Aneho
Gr. Popo
Kotonu
Porto Novo
Lagos
Benin
Sapele
Wari
Burutu
R. Forcados
Ikot Ekpene
Calabar
Bonny
Brass
Akassa
Buea
Fernando Po
Bijer
0 Greenwich
15
10
5
Bale & Danielsson Ltd lith.

prevalent. In this connection the following quotation from Bates' 'Naturalist on the Amazons' (p. 171, 6th ed.) may have some significance:—

"On arriving at Pará, I found that once cheerful and healthful city desolated by two terrible epidemics. The yellow fever, which visited the place the previous year (1850) for the first time since the discovery of the country, still lingered, after having carried off nearly 5 per cent. of the population. The number of persons who were attacked, namely, three-fourths of the entire population, showed how general is the onslaught of an epidemic on its first appearance in a place. At the heels of this plague came the small-pox. The yellow fever had fallen most severely on the whites and mamelucos [cross-breeds, Indian and European], *the negroes wholly escaping*; but the small-pox attacked more especially the Indians, negroes and people of mixed colour, sparing the whites almost entirely, and taking off about a twentieth of the population in the course of the few months of its stay."

The striking difference in the incidence of these two epidemics renders it difficult to avoid the conclusion that it was due to the existence of immunity, either naturally or artificially produced. If, however, the long prevalence of yellow fever in West Africa has produced a marked insusceptibility among the indigenous races, we need not anticipate the occurrence of such devastating epidemics as have swept over portions of Tropical America, though the disease would remain a serious menace to all new-comers.

Again, we should have to reckon with the possibility that an immune negro might serve as a reservoir of the disease if introduced into a country where *S. fasciata* occurs, but where there is no yellow fever.—Ed.]

SOME OBSERVATIONS ON THE BIONOMICS OF *TABANUS DITÆNIATUS*, MACQUART, AND *TABANUS KINGI*, AUSTEN.*

By HAROLD H. KING,

Government Entomologist, Anglo-Egyptian Sudan,
Wellcome Tropical Research Laboratories, Khartoum.

Tabanus ditæniatus, Macq.

The distribution of this Tabanid as given by Austen † is a very wide one. In Africa it occurs from the Transvaal in the south to Egypt in the north, while outside the bounds of Africa it is found in Baluchistan, India, Ceylon, China and Japan. In the Anglo-Egyptian Sudan it occurs fairly commonly in the south, but until this year it had not been recorded from the northern provinces.

The larvæ were taken early in March of this year in a small water channel—locally known as a 'gadwal'—on the estate belonging to the Sudan Plantation Syndicate Ltd., at Zeidab, Berber Province. The water was for the most part overgrown with a covering of green slime, and if this was cleared away a few larvæ could generally be seen on the surface. On stirring up the mud at the bottom and edges of the water more would appear, while if one waited for an hour or so specimens would continue to rise. They were apparently living in the mud at the bottom of the pools and coming periodically to the surface to breathe. They could be seen rising to the surface by a lashing motion, and if left undisturbed would, after a few seconds, sink out of sight again.

Some forty odd larvæ of various sizes were taken on March 9th and placed in a jar containing water, slime and hollow grass stems; most of these had disappeared by the next morning, the larger ones having devoured their smaller brethren. On March 10th more than a hundred were secured, and, together with the survivors from the previous day, divided among three jars (only three being available), two containing wet mud, and the third water with hollow grass stems and other débris. Earthworms were provided as food, but were not taken very readily; the larvæ seemed to prefer to eat each other. They were brought to Khartoum on March 11th, and the following morning each of the thirty-three which were still living was placed in a separate jar containing clean river sand and water. They fed freely on tiny earthworms, but their numbers steadily decreased until about April 16th,

* A record of research work carried out in the Wellcome Tropical Research Laboratories and published by permission of the Director of Education, Sudan Government.

† Austen, E. E., African Blood-sucking Flies, pp. 118, 119.

when the thirteen survivors, having attained maturity, ceased to feed. Up to this stage, if the sand in which they were living was allowed partially to dry out they became very restless until water was given them again, but hereafter they preferred sand which was only slightly damp. In appearance as well as habits they altered considerably at this stage of their existence. While young and growing they possessed well developed pseudopods and conspicuous dark dorsal markings: now, however, their pseudopods became small and in colour they appeared uniform yellowish white.

These thirteen larvæ were left undisturbed until April 26th, when one specimen was washed out and found to have pupated—probably within the previous two days, as the eyes had not begun to show the colour which they acquired later. On the following day, by carefully picking over the sand, two more pupæ were discovered. Prior to pupating the larvæ had made a number of tunnels in the sand, and the pupæ were lying in a more or less upright position in the tunnels and near the surface.

On April 28th the writer left Khartoum, and was absent travelling in the provinces until May 30th, by which date one larva had died and twelve completed their life cycles, producing eight females and four males. The first had emerged on April 29th or 30th, so the period passed in the pupal stage was probably about six days.

Immature larva (fig. 1).—Length 18 mm. Colour yellowish white, with dark markings composed of pubescence. Mandibles dark brown to black, slightly serrated. Anterior margins of the meso- and metathoracic segments dark, except on the venter. A ring of pseudopods, eight in each ring—two dorsal, two lateral, four ventral,—on the anterior third of each abdominal segment

Fig. 1.—Immature larva of *Tabanus ditæniatus*, Macq.

a, lateral view of larva, ×3; *b*, 3rd and 4th abdominal segments, ×6; *c*, 8th abdominal segment, ×6.

except the eighth, well developed (except the dorsal pairs on the first and second segments) and bearing spines or hooks. Spines are also present between the pseudopods on each ring. The rings on the first and second segments edged before and behind with dark pubescence, especially on the dorsum, the pubescence extending between the dorsal and lateral pseudopods, thus enclosing the dorsal pseudopods in a dark ring. On each of the third to the seventh segments inclusive is a patch of dark pubescence between the lateral

and dorsal, and between the dorsal pseudopods,—three patches on each ring—the median patch being conspicuous. To the naked eye these median patches constitute a median dorsal line of black dots. On each of the third to the sixth segments, inclusive, are two patches of dark pubescence immediately anterior to the dorsal pseudopods. The posterior margin of the eighth segment bears dark pubescence. The surface of the larva other than that bearing pubescence is shiny and longitudinally striated.

Mature larva (fig. 2).—Length 25 mm. Colour yellowish white. Mandibles dark brown to black, slightly serrated. Thoracic segments shiny and longitudinally striated, except the anterior margins, which are opaque and pubescent. On the prothoracic segment are five longitudinal grooves—one ventral, two sublateral, two subdorsal—not extending to the posterior border. On the meso- and metathoracic segments are eight such grooves, four on either side. The first abdominal segment bears one pair of ventral pseudopods; the second segment one pair of ventral and one pair of lateral (fig. 2, *b*);

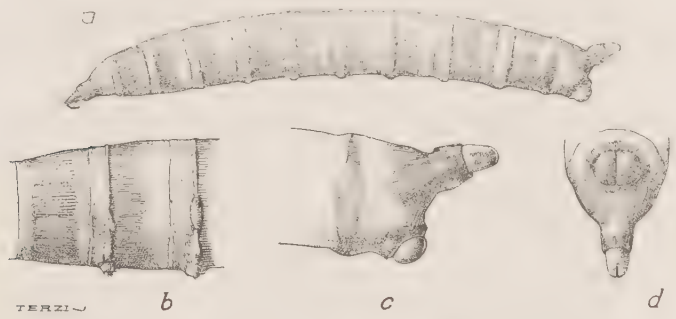

Fig. 2.—Mature larva of *Tabanus ditæniatus*, Macq.

a, lateral view of larva, ×3; *b*, lateral view of 1st and 2nd abdominal segments, ×6; *c*, lateral view of anal segment, ×6; *d*, posterior view of same (inverted), ×6.

the third to the seventh, two pairs of ventral and one pair of lateral. Traces of most of the other pseudopods are present, especially of the dorsal pseudopods on the fourth to the seventh segments. The pseudopods bear small colourless spines or hooks, and similar, though smaller, spines are situated between the pseudopods and on the dorsum of the first, second and third segments where the pseudopods are wanting. On the dorsum of the first and second segments these spines constitute a double band. The posterior third of each abdominal segment is shiny and longitudinally striated. The anus is edged with pubescence. The siphon when exserted appears rather shorter than the eighth segment (fig. 2, *c*, *d*).

Pupal case (fig. 3).—Length 17 mm. Colour yellowish brown, thoracic tubercles and abdominal spiracles darker, the former bearing hairs. On the posterior third of the second to the seventh abdominal segments is a ring of backwardly pointing spines, shortest on the second segment and longest on the seventh. The eighth segment terminates in a coronet of six teeth (fig. 3, *b*, *c*), chestnut brown in colour, darker at the tips, the lateral pair by far the largest, the dorsal and ventral pairs being about equal in size, the former sometimes slightly the larger. The dorsal pair arises from between

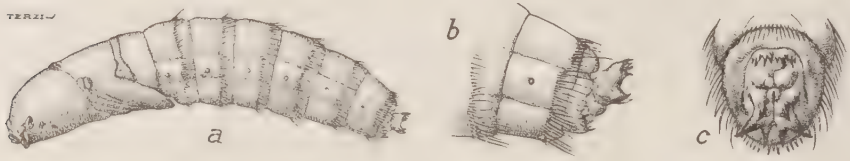

Fig. 3.—Pupa of *Tabanus ditæniatus*, Macq.

a, lateral view of pupa, ×3; *b*, lateral view of part of 6th, 7th and 8th abdomina segments, × 6; *c*, posterior view of 8th abdominal segment (inverted), × 6.

the lateral teeth, the four teeth constituting a row. Ventrally placed to this coronet are two rows of similar teeth, each row consisting of from two to five teeth, the two rows together constituting an interrupted transverse row. These teeth are unequal, and vary in size and number in different specimens.

The pupa when first formed is yellow with a greenish tinge, especially on the thorax. Later, as the imago develops, the eyes show as deep maroon and the thorax becomes generally darker.

Tabanus kingi, Austen.*

Khor Arbat (fig. 4), the locality in which this seroot occurs, is situated about 22 miles N.N.W. of Port Sudan, and consists of a stream of slightly brackish water running in a gorge in the rocky hills. On emerging from the hills into the plain the stream loses itself in the sand. In the autumn, during the brief rainy season, it comes down in spate, and is then of considerable size, but in April—the month in which these observations were made—it is, except where pools exist, not more than a few inches in depth. The bed of the stream is stony and there is little or no vegetation growing on its banks.

* For a description and figure of this species, see p. 291.

The female fly deposits her eggs in a rounded mass on a rock rising sheer from the water (fig. 5), generally slightly overhanging, and from 6 inches to 15 inches above water level. Rocks chosen for this purpose overhang comparatively deep pools—from 18 inches upwards—in which the water moves but slowly. Such rocks occur only every here and there; in the mile or so of stream searched by the writer, only three rocks bearing traces

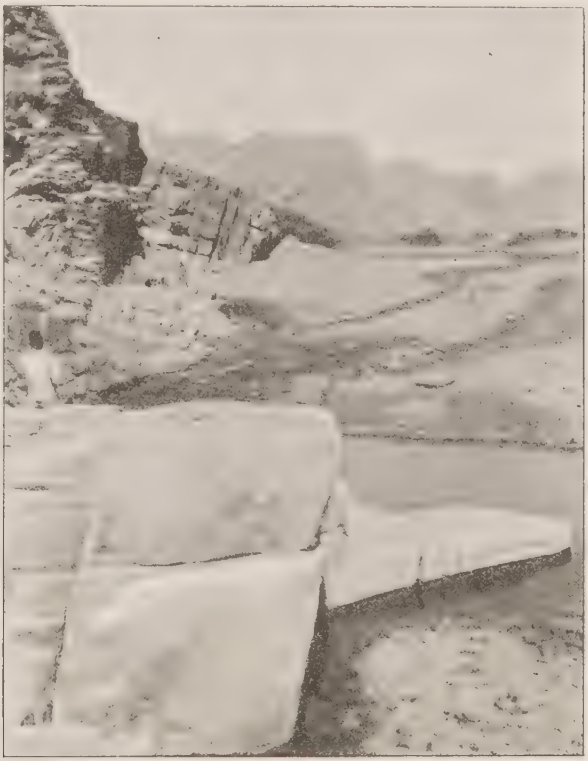

Fig. 4.—View of Khor Arbat, Anglo-Egyptian Sudan; looking up-stream.

of having been used by this Tabanid for purposes of ovipositing were found. On one of them were the remains of several hundred egg-masses lining a small crack in the face of the rock from 2 ft. to 3½ ft. above the water level. As none of the fresh egg-masses found were situated more than 15 inches above water level, these old masses had probably been deposited when that level was higher. Altogether seven females were taken in the act of ovipositing, and several more seen. No particular time of the day seems

to be chosen for the act; one was taken ovipositing at 11.40 A.M. and another at 4.40 P.M., and unlike *T. biguttatus*, Wied., the only other seroot which the writer has observed ovipositing in the field, the female of this Tabanid does not lose her natural wariness while engaged in depositing her eggs. In fact, she is often more difficult to capture than when merely sunning herself on a rock.

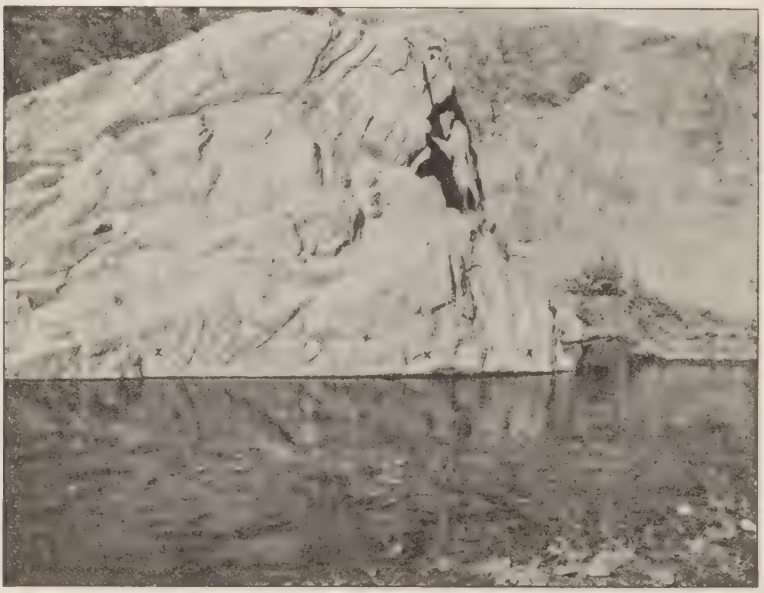

Fig. 5.—A rock at Khor Arbat, showing sites selected by *Tabanus kingi* for ovipositing (indicated by crosses); the three lower crosses represent freshly laid egg-masses.

The egg-masses (fig. 6, *a*) vary in size, and no count of the number of eggs contained was made, but the average mass is believed to consist of about five hundred. When freshly laid the mass is glistening white and can be seen from a considerable distance; but within a few hours it takes on a mottled grey hue, which so closely resembles the colour of the rock that it is not easily detected. While the fly is occupied in laying her eggs, numbers of a tiny Hymenopteron assemble and proceed to add their eggs to the mass, continuing to do so after the fly has gone away. From some twenty egg-masses collected from the rocks about equal numbers of this egg-parasite and of the Tabanid larva were obtained. Specimens have been sent to the Scientific Secretary of the Entomological Research Committee for determination.

One seroot taken in the act of ovipositing completed her egg-laying in a collecting box on the evening of April 13th. These eggs had hatched by the morning of April 19th, the incubation period being therefore about five days. Under normal conditions, exposed to the sun, it may possibly be less. The larvæ from these eggs were allowed to fall from the egg-mass into a basin containing water and stones, and were provided with portions of earthworms and tiny coleopterous and dipterous larvæ obtained from wet moss. They refused to feed however and all perished; probably at this stage of their existence they require brackish running water.

In places, the stream at Khor Arbat is very shallow and ripples over and around stones; under these stones were taken larvæ of various sizes, for the most part nearly mature. Apparently stones which were not quite, or barely, covered with water were chosen by the larvæ in order that they might come up to breathe without losing their hold, and so avoid the danger of being carried away by the current. Usually only a single larva was found under one stone, and in every case where two or three were together a mortal combat was taking place. If a larva was placed on one's hand it would at once endeavour to drive its mouth-hooks through the skin, and where the skin was thin it would succeed in inflicting a sharp pricking pain. Owing to their cannabalistic habits the number of larvæ which could be transported was restricted to the number of vessels available; so though nearly two hundred were taken from the stream, only forty-two were brought alive to Khartoum. There they were placed in jars containing coarse sand, brought from Khor Arbat, and water, and fed on medium-sized earthworms. They took these willingly when hungry, but appeared to need food only once every two or three days. The writer left Khartoum on April 28th, and when he returned on May 30th, the majority of these larvæ were dead; one, however, had completed its life cycle and seven were still living. Six of these seven pupated during the next three weeks, but died as pupæ. The pupal period is probably about six days, for one which pupated on May 5th appeared to be mature on May 11th, when it perished.

One empty pupal case was taken under a stone in the bed of the Khor Arbat stream, and the fly must have crept up the stone through several inches of running water before gaining the air.

Although this Tabanid in its adult form closely resembles *T. tæniola*, Pal. de Beauv., in its larval stage it differs markedly from that species. The larva is admirably adapted for clinging to stones in rapidly running water, its unusually long pseudopods, armed with powerful hooks, being retractile and capable of being used as suckers. None of the other Tabanid larvæ which the writer has seen hitherto has possessed an anal proleg.

Besides the seven specimens mentioned above as having been taken in the act of ovipositing, two or more were caught sucking blood from camels. No males were seen.

Egg.—Length 2 mm. Colour white, becoming darker as the embryo within develops ; spindle-shaped.

Mature larva (fig. 6).—Length 35 mm. Colour varying from pale grey through dusky grey to deep chestnut brown. Mandibles dark brown to black, long and powerful, slightly serrated. Anterior margins of meso- and metathoracic segments dark. A smooth shiny pale area on the dorsum of each thoracic segment—on the prothorax this area is concave anteriorly, convex posteriorly and with parallel sides ; on the meso- and metathoracic segments it appears to the naked eye diamond-shaped, though sometimes it is actually hexagonal. On the venter of the prothorax are two shiny pale longitudinal areas, each bearing several long black hairs arising from a single pore ; a similar but larger area is situated on each of the meso- and metathoracic segments, bearing two similar tufts of hairs. On either side of the meso-

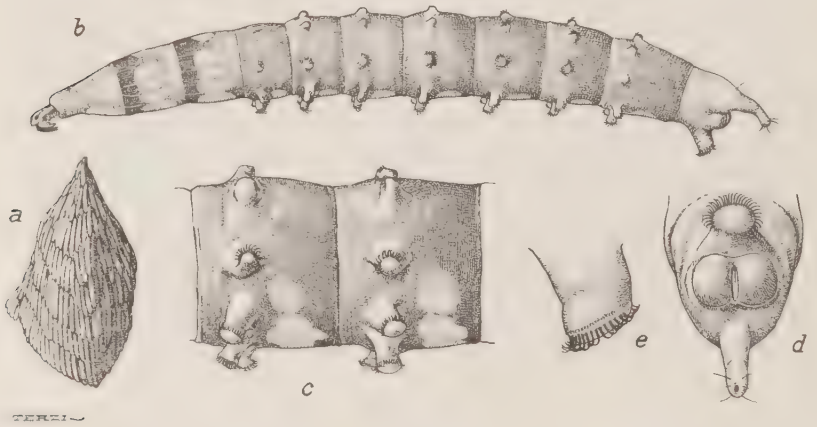

Fig. 6.—Egg-mass and mature larva of *Tabanus kingi*, Austen.

a, egg-mass, ×6 ; *b*, lateral view of larva, ×3 ; *c*, lateral view of 4th and 5th abdominal segments, ×6 ; *d*, posterior view of anal segment (inverted), ×6 ; *e*, lateral view of anal pseudopod.

and metathoracic segments are three longitudinal areas, not extending to the margins of the segments, longitudinally and deeply striated. On the anterior margins of the meso- and metathoracic segments on either side are four paler lines extending backwards to form the divisions and edges of the three striated areas. On the anterior third of each abdominal segment except the eighth is a ring of pseudopods, eight in each ring,—two dorsal, two lateral, four ventral—except on the first segment where the dorsal pair is wanting. The dorsal pseudopods are never well developed, and with the exception of those on the fifth (fig. 6, *c*), sixth, and seventh segments, are unprovided with hooks. The lateral and ventral pseudopods are very long

and bear at the apices long strong hooks, chestnut brown in colour, sometimes darker at the tips. On the median pair of ventral pseudopods on the fourth, fifth, and sixth segments these hooks form a complete circle, but on the remaining pseudopods bearing hooks the circle is incomplete. Immediately below these hooks is a row of tiny spines. Immediately behind the ventral pseudopods on the first to the seventh segments is a shiny striated area. On the venter of the eighth segment, anteriorly placed to the anus, is a pseudopod equal in size and similar to the ventral pseudopods on the other segments, and bearing an incomplete circle of hooks (fig. 6, *d*, *e*). Scattered over the surface of the larva are occasional black hairs. The siphon when exserted is shorter than the eighth segment, and bears a number of black hairs. The dark appearance of the larva is due to tiny dots of pubescence arranged closely together except on the shiny areas mentioned above.

The skin of the larva frequently bears scars of old wounds.

Pupal case (fig. 7).—Length 20 mm. Colour yellowish brown, thoracic tubercles and abdominal spiracles darker, the former bearing hairs. On the posterior third of the second to the seventh abdominal segments is a

Fig. 7.—Pupal case of *Tabanus kingi*, Austen.

a, lateral view of pupal case, ×3; *b*, lateral view of anal segment, ×6; *c*, posterior view of same (inverted), ×6.

ring of backwardly pointing spines, shortest on the second segment and longest on the seventh. The eighth segment terminates in a coronet of six teeth (fig. 7, *b*, *c*), chestnut brown in colour, darker at the tips, the lateral pair by far the largest, the dorsal and ventral pairs being equal in size. These teeth are arranged roughly in a circle. Ventrally placed to this coronet are two rows of five comparatively thin spines, of varying lengths, together constituting an interrupted transverse row. Dorso-laterally placed to the coronet are two rows of spines similar to the ventral row.

The dorsum of the abdomen is sometimes clothed with black pubescence arranged in four longitudinal stripes. On the sixth and seventh segments these stripes merge, and on the seventh segment the pubescence is confined to the posterior third. The pubescence is wanting on the dorsum of the

eighth segment, but is present on the venter of the seventh, and a small patch is situated immediately below the coronet on the eighth segment.

The pupa when first formed is yellowish. Later, as the imago develops, the eyes appear dark with a greenish tinge, and the thorax becomes generally darker.

The thanks of the writer are due to Capt. W. B. Fry, R.A.M.C., and to Mr. A. Marshall, Laboratory Assistant, for tending these larvæ while he was away from Khartoum.

The drawings are by the well-known entomological artist Mr. A. J. Engel Terzi.

ON TABANIDÆ COLLECTED IN NORTH-EASTERN RHODESIA AND KATANGA, CONGO FREE STATE, BY Dr. S. AND Mr. S. A. NEAVE, WITH DESCRIPTIONS OF NEW SPECIES.

By ERNEST E. AUSTEN.

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Part I.—PANGONIINÆ.

Through the kindness of Mr. S. A. Neave, the types of all new species described below have been presented to the British Museum (Natural History).

Genus CHRYSOPS, Meigen.

Chrysops neavei, sp. n. (Fig. 1.)

♀.—Length (1 specimen) 7·5 mm.; width of head 2·4 mm.; width of front at vertex just under 1 mm.; length of wing 7·25 mm.

Somewhat resembling a small specimen of Chrysops silacea, *Austen, in the coloration and markings of the thorax and abdomen and in general appearance, but easily distinguishable by the wing-markings.—Head chrome-yellow*; thorax clove-brown, with longitudinal, chrome-yellow pollinose stripes; scutellum clove-brown, its lateral and posterior border broadly ochraceous-rufous and clothed with chrome-yellow pollen; abdomen ochraceous, dorsum with a pair of admedian, longitudinal, clove-brown stripes, extending from base to a little beyond middle; wings without a sharply defined dark transverse band, proximal portion (except costal border) hyaline, costal border and distal portion from level of distal extremities of basal cells mummy-brown, second submarginal cell and distal extremities of first four posterior cells paler.*

Head clothed with chrome-yellow pollen, except on clove-brown frontal callus, on a relatively large and conspicuous similarly coloured spot surrounding the ocelli, on the shining, dark mummy-brown facial tubercle or tubercles, and on an ill-defined clove-brown area on the jowl below each eye; *frontal callus* roughly semicircular in outline, and very convex and prominent, distinctly separated from eye on each side, somewhat paler in centre of lower margin; *ocellar spot* connected behind with margin of vertex but well separated from eyes; *facial tubercles*, in typical specimen at any rate, presenting the appearance of a single, polished, elongate cordate tubercle,

* For names and illustrations of colours, see Ridgway, 'A Nomenclature of Colors for Naturalists' (Boston: Little, Brown, & Company, 1886).

cinnamon-rufous in middle, occupying greater portion of middle part of face and extending to lower margin of latter; under surface of head, sides of face, and median portion of vertical margin clothed with yellowish hair; *palpi* small, lanceolate, ochraceous-buff, clothed on outer surface with yellowish hair; first and second joints of *antennæ* moderately incrassate, first joint 1 mm. in length, tawny-ochraceous, second joint about 0·5 or 0·6 mm. in length, darker, mummy-brown, both joints clothed with short, blackish hair (third joint missing in case of type). *Thorax*: dorsum with a pair of admedian, chrome-yellow pollinose, longitudinal stripes, extending from front to hind margin, each stripe connected at each extremity with a similar lateral stripe running above base of wing from humeral to post-alar callus; pleuræ largely covered with chrome-yellow pollen, and clothed with similarly coloured

Fig. 1.—*Chrysops neavei*, Austen, ♀. × 6.

hair. *Abdomen*: clove-brown admedian stripes on dorsum interrupted on hind margins of segments, diminishing in width and becoming less distinct on third and fourth segments, and extending from base (where they appear to be in contact on first segment beneath scutellum) to a little beyond middle of fourth segment, where they die away; hind margins of segments paler, yellowish pollinose; venter unicolorous, somewhat paler than dorsum, clothed with short, chrome-yellow hair. *Wings*: proximal margin of infuscated distal portion, from base of third longitudinal vein to that of fifth posterior cell, nearly straight; stigma mummy-brown. *Halteres* buff. *Legs*: front tibiæ slender, not incrassate; front coxæ, femora, and tibiæ ochraceous, first joint of front tarsi mummy-brown, its under surface darker (middle and hind legs and last four joints of front tarsi missing in typical specimen); front

coxæ, front femora, and outer surface of front tibiæ clothed with chrome-yellow hair; inner and under surfaces of front tibiæ clothed with minute black hairs.

Katanga, S.E. Congo Free State: Kundelungu, plateau east of Lufira R., 5000–6000 ft., between Aug. 28 and Sept. 3, 1907 (*Dr. Sheffield Neave*).

In addition to the wing-markings, the dark and very prominent frontal callus, the sharply defined ocellar spot, the incrassate first joint of the antennæ, and the slender front tibiæ will serve to distinguish *Chrysops neavei* from *C. silacea*, Austen, the only known African species with which it could possibly be confused.

C. nearei is named in honour of its discoverer.

Genus DIATOMINEURA (Subgenus CORIZONEURA), Rond.

Diatomineura virgata, sp. n. (Fig. 2.)

♂ ♀.—Length, ♂ (3 specimens) 18 to 20 mm., ♀ (2 specimens) 17 to 18 mm.; width of head, ♂ 4·8 to 5 mm., ♀ 4·8 mm.; width of front of ♀ at vertex 1 mm.; length of proboscis, ♂ 18·4 mm., ♀ 19 mm.; length of wing, ♂ 15 to 16·5 mm., ♀ 16 mm.

Body rather narrow and elongate, at least in ♂: dorsum of thorax gallstone-yellow pollinose, with three conspicuous, black or clove-brown, longitudinal stripes; abdomen ochraceous, dorsum with a median series of black blotches, dorsum of fifth and sixth segments in ♂ wholly black, except lateral margins and posterior angles, and also extreme hind margin of fifth segment; wings sepia-coloured, costal cells mummy-brown; legs ochraceous-rufous, tips of tarsi brown.

Head buff-yellow pollinose, sides of face brown; face prominent, with an elongate, sub-triangular, shining black callus on each side below antenna; in ♀ vertex clove-brown, and a spear-head-shaped blackish mark on front, in middle line above base of antennæ; jowls and basi-occipital region clothed with dull whitish hair; *palpi* dark brown or clove-brown in ♂, cinnamon-rufous in ♀; *proboscis* clove-brown; first and second joints of *antennæ* fawn-coloured, pollinose, third joint orange-rufous. *Thorax*: median black or clove-brown stripe on dorsum rather narrow, straight, extending from front margin to præsutural furrow, in ♀ sometimes partly obscured posteriorly by yellow pollen; outer clove-brown stripes about twice as broad as median stripe, extending from anterior margin to inner angles of postalar calli, their outer edges curved; admedian gallstone-yellow stripes darker than sides of dorsum, with a lighter yellow streak on their outer margins in front; dorsum of thorax clothed with short, bright, ochre-yellow hair, posteriorly and on posterior portion of dark stripes, especially in ♂, intermingled with or entirely or in part replaced by fine, erect, black hair; pectus and pleuræ clothed with cream-buff-coloured hair; a ridge of black hair running from

humeral callus to base of wing on each side, sometimes more or less buried in and concealed by the adjacent pale hair : *scutellum* black or clove-brown, yellowish pollinose above, anterior border of dorsum sometimes devoid of pollen : scutellum clothed above with erect black hair, intermingled at sides

Fig. 2.—*Diatomineura virgata*, Austen, ♀. × 3.

in ♀, and sometimes also in ♂, with bright yellow hair. *Abdomen* : black blotch on dorsum of first segment extending slightly beyond sides of scutellum (its outer margins usually somewhat concave), narrowed and truncate posteriorly, narrowly separated from hind margin of segment except in middle line ; blotches on second, third and fourth segments resting on front margin in each case, but not reaching hind margin ; blotches on second and third segments somewhat quadrate (blotch on second segment narrower behind) ; blotch on fourth segment wider than long ; all foregoing blotches smaller in

♀ than in ♂; second, third and fourth segments sometimes each with a small black spot on each side; hind borders of fourth and following segments in ♀ yellowish pollinose, median blotches on sixth and seventh segments in ♀ expanded into a clove-brown transverse band in each case, not reaching lateral margins; dorsum on sides of first and second and on posterior angles of following segments, also on posterior borders of fourth and following segments, clothed with minute, appressed, shining ochre-yellow hair, elsewhere clothed with minute black hairs; venter orange-ochraceous or ochre-yellow, entirely devoid of markings, and clothed with minute, appressed, ochre-yellow or buff-yellow hairs. *Squamæ* ochraceous-buff. *Halteres* cream-buff. *Legs* clothed with ochraceous-rufous or tawny hair, posterior tibiæ and tarsi also with minute black hairs on outer side; tips of first and second joints of front tarsi in ♂, especially tip of second joint, prolonged above.

Katanga, S.E. Congo Free State: Mid-Lualaba Valley, 3000 ft., 18.iv. to 3.v. 1907 (*S. A. Neave*).

The nearest allies of this handsome species are clearly to be found in the group of which *Diatomineura æthiopica*, Thunberg (syn. *Pangonia varicolor*, Wied.; *P. appendiculata*, Macq.), may be taken as the type; from all the members of this group at present known to me, however, *Diatomineura virgata* can readily be distinguished by its conspicuously yellow-and-black-striped thorax.

Diatomineura neavei, sp. n.

♂.—Length (1 specimen) 18 mm.; width of head 5·5 mm.; length of proboscis 12 mm.; length of wing 16·6 mm.

Head, except upper part of prominent facial callus, which is shining black, clay-yellow pollinose; thorax sepia-coloured, with narrow blackish longitudinal streaks on dorsum; abdomen tawny, with black median blotch on dorsum of each of first four segments, remaining segments, except posterior angles of fifth, wholly black; wings strongly tinged with sepia, costal cells and membrane bordering longitudinal veins adjacent thereto light mummy-brown; legs clove-brown, middle tibiæ, extreme base of front tibiæ, and front and middle tarsi, except tips of joints, mummy-brown.

♀.—Length (8 specimens) 17·75 to 19 mm.; width of head 5·4 to 6 mm.; width of front at vertex just under 1 mm.; length of proboscis 10·25 to 10·5 mm.; length of wing 17 to 17·6 mm.

Head, except shining black facial callus and blackish anterior extremity of face, clay-yellow pollinose; dorsum of thorax and of first segment of abdomen clay-brown, thorax (in specimens in good condition) with a brighter (clay-yellow), broad, median, longitudinal stripe; dorsum of second and following segments of abdomen shining clove-brown, greyish pollinose on hind borders, which, except median portions of those of terminal and penultimate segments, are clothed with

short, appressed, whitish hairs, forming transverse bands which are deeper at the sides; coloration of wings and legs as in ♂.

♂.—*Head*: median portion of frontal triangle clothed with erect black hairs; median portion of face strongly tumid, hemispherical when viewed from above, forming *a single facial callus*, which is shining black above and blackish (yellowish pollinose) below: lower portion of sides of swollen part of face clothed with yellow hairs, a few dark brown hairs at bottom of sides of face, jowls and basi-occipital region thickly clothed with straw-yellow hair; *eyes* rather large and tumid: *palpi* and *proboscis* clove-brown; first joint of *antennæ* clove-brown, second joint dull vandyke-brown, both joints clothed with blackish hair (third joint missing in case of type). *Thorax*: ground-colour black, clothed with sepia-coloured pollen, and on dorsum with fine, erect, black hair; a narrow, black, median stripe on dorsum, running from front margin to præscutellar furrow, and expanding slightly in front of latter; a somewhat less distinct, narrow, admedian, blackish stripe on each side of median stripe on dorsum, midway between median stripe and lateral margin; pleuræ, pectus, and area on sides of dorsum immediately behind humeral calli clothed with ochreous hair; a horizontal ridge of thickset, blackish hair on each side, running from humeral callus to above base of wing; no tuft or ridge of bright yellowish hair above base of wing or on postalar callus; scutellum clothed with black hair, and having a dull, clove-brown, transverse area above, adjoining its anterior margin but not extending to the sides. *Abdomen*: black blotch on dorsum of first segment somewhat quadrate, narrowing posteriorly, and extending to hind margin; blotch on second segment resting on front margin, narrowing posteriorly about middle of segment, and not reaching hind margin; blotch on third segment smaller, irregular in outline, and not reaching either front or hind margin; blotch on fourth segment occupying about one third of width of segment, extending from front to hind margin, and narrowing somewhat posteriorly; posterior half of dorsum of fourth and fifth segments yellowish pollinose, dorsum of sixth segment entirely yellowish pollinose; black blotches and sides (except posterior angles) of second and third segments clothed with black hair, remainder of dorsum clothed with bright chrome-yellow hair; venter ochraceous, clothed with short, chrome-yellow hair; fifth and following segments clove-brown, pollinose. *Squamæ* mummy-brown. *Halteres* dark sepia-coloured. *Legs* clothed entirely with black hair, except on under side of first and on lower distal angles of second and third joints of front tarsi, where the hair is ochraceous rufous: as in case of ♂ of *Diatomineura* (*Corizoneura*) *distincta*, Ricardo, tips of first and second joints of front tarsi are remarkably prolonged above, so that distal extremities of these joints, viewed from the side, are very oblique; tip of second joint fringed above with longer black hair; tip of third joint also somewhat prolonged above, though to a less extent.

♀.—*Head*: vertex and sides of front clothed with short black hair;

facial callus as in ♂; sides of face and sides of swollen part of face bare, except immediately above jowls, where are a few dark brown hairs; jowls and basi-occipital region clothed with straw-yellow hair, paler and brighter than corresponding hair in ♂; proximal joint of *palpi* dark brown, terminal joint chestnut; *proboscis* clove-brown; first and second joints of antennæ blackish, yellowish pollinose, clothed with blackish hair, third joint cinnamon-rufous. *Thorax*: ground-colour black, with a clay-brown or lighter pollinose covering, and clothed on dorsum with short ochreous pile, sparsely intermixed with blackish pile; narrow blackish stripes on dorsum as in ♂, but median stripe less distinct, except in front and its posterior expansion; admedian stripes sometimes widening in front of transverse suture; pectus and pleuræ clothed with yellowish or ochreous hair, ridge of hair above base of wings and on lower margin of front portion of postalar calli also ochreous; a ridge of black hair on each side extending from humeral callus to base of wing; posterior border of scutellum clothed with brownish hair. *Abdomen*: dorsum of first segment, except beneath scutellum, clothed with ochraceous hair, which is longer and more conspicuous on posterior angles; whitish hair on hind borders of following segments sometimes becoming yellowish towards middle: dorsum of second and following segments, except where clothed with whitish or yellowish hair, covered with short black hair; venter shining clove-brown, clothed with short, appressed, whitish hairs. *Squamæ* and *halteres* as in ♂. *Legs* clothed with black hair, first three or four joints of front tarsi clothed below with ochraceous-rufous hair; tips of none of the joints of front tarsi prolonged above.

Katanga, S.E. Congo Free State: type of male and one female from Kambove, 4000–5000 ft., 2.iv.1907; two females from Lualaba R., 21 and 27.iv.1907; type of female and four other females from Mid-Lualaba Valley, 3000 feet., 18.iv. to 3.v.1907 (*S. A. Neave*).

This fine species, with which I have much pleasure in associating the name of its discoverer, is evidently allied to *Diatomineura* (*Corizoneura*) *distincta*, Ricardo (East Africa and Abyssinia), to which, in both sexes, it presents a general resemblance in appearance, besides agreeing with it in the character of the sexual colour-dimorphism. Apart, however, from its generally larger size, *Diatomineura neavei* can at once be distinguished from *D. distincta* by, in both sexes, the darker coloration of the legs, and by the upper portion of the tumid region of the face being entirely shining, instead of wholly pollinose, as in *D. distincta* ♂, or pollinose in the middle, as in *D. distincta* ♀. Furthermore, *D. neavei* ♂ is distinguished from *D. distincta* ♂ by the ridge of hair above the base of the wing on each side being dark brown or blackish instead of pale yellowish, while in the case of the ♀ the grey bands on the hind borders of the abdominal segments are much more conspicuous in *D. distincta* than in *D. neavei*, and the hair on the first abdominal segment of the latter is ochraceous instead of pale yellow.

Diatomineura inornata, sp. n.

♀.—Length (1 specimen) 17·5 mm.; width of head 5·4 mm.; width of front at vertex just under 1 mm.; length of proboscis 11 mm.; length of wing 16·4 mm.

Dorsum of thorax sepia-coloured, unstriped; abdomen russet, without dark markings; wings suffused with light mummy-brown, costal cells and extreme base dark mummy-brown; legs cinnamon-rufous, middle tibiæ ochraceous-buff, tips of tarsi brown.

Head buff-yellow pollinose; sides of face brown, a shining dark brown callus directly below each antenna, a dark brown, ill-defined, median streak on front above base of antennæ, and a small, cinnamon-rufous fleck on vertex; jowls and basi-occipital region clothed with cream-buff-coloured hair; *palpi* and *antennæ* cinnamon-rufous, first two joints of latter greyish pollinose and clothed with yellowish hair; *proboscis* clove-brown, tips of labella burnt-sienna-coloured. *Thorax*: dorsum dark gallstone-yellow pollinose, clothed with short maize-yellow hair, which posteriorly is intermixed with longer blackish hair; a conspicuous ridge of longer maize-yellow hair on each side above base of wing and on postalar callus; pleuræ and pectus clothed with maize-yellow hair. *Abdomen*: dorsum clothed on sides of first and second segments with short, appressed, ochre-yellow hair, longer on posterior angles of first segment; third and following segments clothed with minute black hairs; posterior angles of second and fourth segments clothed with silvery hair, which is continued as a transverse band along hind margin of fourth segment, but on central portion of posterior border of second segment is replaced by minute, appressed, ochre-yellow hair; posterior angles of fifth and sixth segments fringed with whitish hairs; venter without dark markings, clothed with minute, appressed, ochre-yellow hairs, which are longer on terminal segment. *Squamæ* and *halteres* ochraceous-buff. *Legs* clothed with minute ochre-yellow or yellowish hairs; front tibiæ buff-coloured at extreme base in front.

Katanga, S.E. Congo Free State: between Bunkeya and Kambove, 3500 ft., September, 1907 (*Dr. Sheffield Neave*).

This species, which, like the foregoing, belongs to the *D. æthiopica* group, is recognisable by the absence of markings on the abdomen.

Genus PANGONIA, Macq.

Pangonia oldii, Austen.

Pangonia oldii, Austen, Ann. Mag. Nat. Hist. ser. 8, vol. i, p. 215 (1908).

Of this species, which was originally met with in the Nyasaland Protectorate, fourteen females ranging in length from 14 to 17 mm. were brought back by Mr. S. A. Neave from the Katanga District, Congo Free

State. While agreeing with the type in all essential respects, these specimens, as is not surprising, show certain slight divergences from the typical form. Thus, in many individuals the dorsum of the second abdominal segment shows a tendency to become more or less clove-brown, the darker colour spreading from the anterior margin towards the centre. Again, the hair on the posterior angles of the first abdominal segment is paler than in Nyasaland specimens, the costal cells are generally darker brown and present a greater contrast with the rest of the wing in colour, and the hair on the outer side of the hind tibiæ, instead of being wholly black, is on the proximal half mixed with, or more or less replaced by, whitish or yellowish hair.

The localities (all of which are in or near Katanga) and dates of capture of Mr. Neave's specimens are as follows:—Mid-Lufira Valley, 3000 ft., May, 1907; Mfungwe to Kayumba, Lower Lufira River, 2000 to 3000 ft., May to June, 1907; and Bunkeya to Kambove, 3500 ft., September, 1907.

Pangonia bubsequa, Austen.

Pangonia bubsequa, Austen, Ann. Mag. Nat. Hist. ser. 8, vol. vii, October 1910, p. 339.

Of this species, the type of which was taken in North Nyasa, Nyasaland Protectorate, by Dr. J. B. Davey, "biting cattle," Mr. Neave obtained a single female in the Luangwa Valley, 12–20 miles west of Petauke, 1700 ft., on April 8, 1905.

Pangonia infusca, sp. n.

♂ ♀.—Length, ♂ (2 specimens) 15·25 to 16·25 mm., ♀ (1 specimen) 17 mm.; width of head, ♂ 4·75 to 5 mm., ♀ 5·4 mm.; width of front of ♀ at vertex just under 1 mm.; distance from upper margin of occiput to anterior extremity of face, in ♂ 3·8 to 4 mm., in ♀ 4·5 mm.; length of proboscis, ♂ 10·5 to 11·8 mm., ♀ 8·5 mm.; length of wing, ♂ 12·5 to 13·6 mm., ♀ 14 mm.; greatest width of wing, ♂ 4·5 to 5 mm., ♀ 5·2 mm.

Closely allied to Pangonia oldii, *Austen, but distinguished by the ground-colour of the dorsal surface of the second as well as following abdominal segments, except hind borders, being entirely clove-brown.—Head, except shining black callus on each side of face, and lower part of sides of face next eyes, which is mummy-brown, yellowish-grey pollinose; dorsum of thorax clay-brown pollinose, clothed with short yellow (straw-yellow or ochre-yellow) hair; first* (i. e. *first visible*) *segment of abdomen dark mouse-grey, hind margin in* ♂ *more or less cinnamon; second and fourth abdominal segments each with a band of short, appressed, white hair* (*silvery-white in* ♂, *yellowish-white in* ♀) *on hind*

border: wings sepia-coloured in ♂, paler, though with a brownish tinge, in ♀, extreme base and costal cells dark brown in ♂, mummy-brown in ♀; femora clove-brown in ♂, chestnut in ♀, hind tibiæ and tarsi dark brown (hind tibiæ mummy-brown in ♀), front and middle tibiæ and tarsi ochraceous-buff, tips of tarsal joints brown or brownish.

Head: face prominent in both sexes, shining black facial calli not extending to front margin of buccal cavity; ♀ with a median, sagittate, cinnamon-rufous callus on front immediately above bases of antennæ, pointing downwards and connected above with a median, dark brown, sagittate mark, pointing upwards, in centre of front; vertex in ♀ dark brown, shining, the dark brown area, at least in type, extending from eye to eye; jowls and basi-occipital region clothed with white or yellowish-white hair; *palpi* dark ferruginous or burnt-sienna-coloured: first and second joints of *antennæ* buff in ♂, orange-rufous in ♀, greyish pollinose in both sexes, clothed in ♂ with long black hairs above, and in ♀ with short yellowish and short black hairs, third joint ochraceous-rufous in ♂, orange-rufous in ♀. *Thorax*: fringe of longer hair on each side on upper margin of mesopleura, above base of wing, and on postalar callus whitish or yellowish, lighter than covering of disc of dorsum; pleuræ in ♂ clothed for most part with black hair, but showing a tuft of yellowish hair beneath squamæ; pleuræ in ♀ clothed with pale buff-yellow hair, but showing some black hairs beneath base of wing. *Abdomen*: first segment clothed beneath scutellum with dark brown or black hair, clothed elsewhere with whitish, yellowish, or ochreous hair, which may form a transverse band on hind border; ground-colour of hind borders of second and following segments dull sepia, sometimes tinged with cinnamon; second and following segments clothed for most part with short black hair; bands of appressed white hair on hind borders of second and fourth segments deeper at sides; lateral margins and posterior angles of fifth segment in ♂, and of fifth, sixth, and seventh segments in ♀ clothed with white or yellowish-white hair; posterior angles of sixth segment in ♂ clothed with yellowish hair, or with a mixture of black and ochreous hair; venter in ♂, except extreme base, sometimes lighter (pale mummy-brown or burnt-umber-coloured) on proximal half, clothed with short brownish hair, and at or near distal extremity sometimes with yellowish hair; venter in ♀ clothed with short, appressed, pale yellowish hair, hind borders of segments cinnamon-brown. *Squamæ* buff. *Halteres*: stalk brownish, knob buff or ochraceous-buff. *Legs*: front coxæ clothed with yellowish hair on anterior surface, femora and remaining coxæ clothed with black hair; front and middle tibiæ in ♂ clothed for most part with short ochreous hairs, middle tibiæ sometimes with black hairs on posterior surface; front and middle tibiæ and tarsi in ♀ clothed with ochreous or pale yellowish hairs; hind tibiæ in ♂ and upper surface of hind tarsi in both sexes clothed with black

hairs ; hind tibiæ in ♀ clothed partly with yellowish and partly with black hairs, the latter predominating at distal extremities.

Katanga, S.E. Congo Free State : Mid-Lualaba Valley, 3000 ft., 18–20.iv. and 14.v., and Mid-Lufira Valley, 3000 ft., May, 1907 (*S. A. Neave*).

Although *Pangonia infusca* may ultimately prove to be a melanistic form of *P. oldii*, Austen, it seems for the present advisable to regard it as a distinct species. In addition to the difference in the ground-colour of the abdomen already pointed out, *P. infusca* may be distinguished from the typical form of *P. oldii* by the shining facial calli being shorter, and in the ♂ by the face being longer, and the ventral surface of the second (visible) abdominal segment being without shining yellowish-white hairs on the hind border.

Pangonia elongata, Ric.

Pangonia elongata, Ricardo, Ann. Mag. Nat. Hist. ser. 8, vol. i, p. 54 (1908) : Austen, Illustrations of African Blood-Sucking Flies, p. 59, plate iii, fig. 24 (1909).

The only examples of *P. elongata* already recorded are those in the British Museum (Natural History), which consist of the type and one other female, both taken near Kilima-Njaro, German East Africa, by the late Bishop Hannington. This handsome species was met with in North-Eastern Rhodesia by Mr. S. A. Neave, who captured two males and one female in the Chambezi Valley, between April 14th and 26th, 1908. Although of considerably larger size than the typical ♀ (the ♀ taken by Mr. Neave measures 18·5 mm. in length, and has a wing-expanse of 40 mm., while the length of the type is 16·4 mm., and its wing-expanse 33 mm.), there can be no doubt that the Rhodesian specimens really belong to *P. elongata*, Ric. Apart from the larger size, the only noteworthy differences exhibited by the ♀ are the somewhat greater depth of the bands of white hair on the hind borders of the third, fourth and fifth abdominal segments, the paler coloration of the light hair on the hind border of the sixth segment and its absence in the middle line, the absence of ochraceous hair on the sides of the seventh segment, and the predominance of black hair on the hind tibiæ.

The Rhodesian ♂ ♂ (which measure 18·75 mm. in length in the case of one specimen, and 21·4 mm. in that of the other) agree with the Rhodesian ♀ in coloration and markings, except that the sixth abdominal segment has no pale band on the hind margin, there being only a few yellowish hairs near each posterior angle, and that the ventral surface of the abdomen, elsewhere than on the white bands, is clothed with black, instead of to a large extent with yellowish hairs. In the case of the larger specimen, the

hairy covering of the dorsum of the thorax is ochre-yellow, and the infuscated distal portion of the wing is of a rich, dark purplish-brown, forming a sharp contrast with the orange-ochraceous proximal portion.

Genus DORCALŒMUS, Austen.

Annals and Magazine of Natural History, ser. 8, vol. vi, *October* 1910, p. 337.

Dorcalœmus auricomus, sp. n. (Fig. 3.)

♀.—Length (6 specimens) 14 to 16·4 mm.; width of head 4·8 to 5·2 mm.; width of front at vertex 0·8 to 1 mm.; distance from upper margin of occiput to anterior extremity of face just under 4 to 4 mm.; length of proboscis 8·4 to 10 mm.; length of wing 12 to 14 mm.; greatest width of wing 4·5 to 5·2 mm.

Head yellowish- or whitish-grey, with dark markings; thorax, including scutellum, olive-brown, greyish pollinose; dorsum of abdomen black, fourth, fifth and sixth segments and also hind borders of second and third clothed with short, appressed, shining, orange-ochraceous (golden-yellow) or ochre-yellow hair, posterior angles of first and sides of second segment usually tawny-ochraceous or ochraceous, hind borders of all segments so far as visible, from first to sixth inclusive, usually ochraceous-buff or buff, first segment sometimes greyish pollinose except dark brown median area extending a little beyond scutellum; wings light mummy-brown, the colour usually more intense next the veins, costal cells and stigma ochraceous; femora black or blackish-brown, extreme tips, tibiæ, and under surface of tarsi ochraceous-buff or buff, tips of hind tibiæ and of front and middle tibiæ on inside, also upper surface of tarsi, brown or brownish.

Head: face conical and prominent, sides of upper part of face clothed with pale yellowish hair, lower part of sides of face brown; upper half of front, except extreme lateral margins, dark olive-brown, with a shining, clove-brown, more or less triangular or sagittate callus; jowls and basi-occipital region clothed with straw-yellow hair: *palpi* clove-brown; *proboscis* black; first and second joints of *antennæ* clove-brown, greyish pollinose, third joint ferruginous. *Thorax*: dorsum, including scutellum, clothed with ochre-yellow hair, a few brownish hairs in front of præscutellar groove; greyish pollinose covering denser on dorsal surface of scutellum and sides of dorsum than elsewhere; pleuræ clothed with straw-yellow hair. *Abdomen*: typical specimen with a large, black, median area on dorsum of first segment, extending to hind margin and tapering somewhat posteriorly; dorsum of first segment clothed with orange-ochraceous or ochreous hair, which as usual is longer on the sides; dorsum of second and third segments, except sides, or at least posterior angles, and hind borders, clothed with

minute black hairs ; sides of dorsum of second segment usually, and sometimes also those of dorsum of third segment, clothed with shining, appressed, orange-ochraceous (golden-yellow) hair ; bands of similar hair on hind borders of second and third segments deeper at sides ; orange-ochraceous hair on dorsum of fifth and sixth segments sometimes interspersed with black hair, or mainly confined to hind borders and elsewhere largely replaced by black hair ; dorsum of seventh segment clothed with black hair ; coloration of venter similar to that of dorsum, ventral surface of second segment

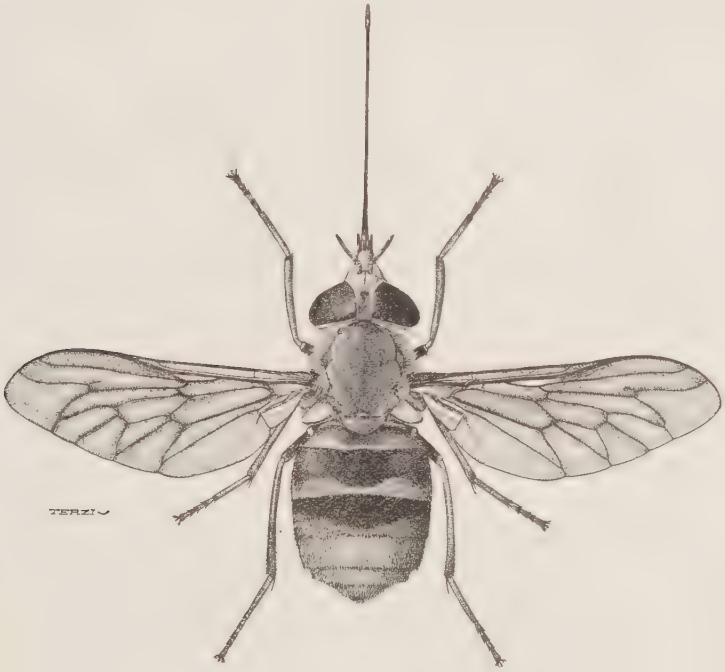

Fig. 3.—*Dorcalœmus auricomus*, Austen, ♀. × 3.

largely clothed with appressed, orange-ochraceous hair, which on third to sixth segments inclusive is mainly confined to hind borders. *Squamæ* cream-buff. *Halteres* dark brown, stalks paler.

Katanga, S.E. Congo Free State : Mid-Lualaba Valley, 3000 ft., 19.iv. and 1.v.1907 (*S. A. Neave*).

Dorcalœmus auricomus is closely allied to the following species, from which, in the ♀ sex at any rate, it differs in the hairy covering of the distal extremity of the abdomen being shining golden-yellow, and in the shining hair on the hind margins of the second, third, and fourth abdominal segments being golden-yellow instead of silvery-white.

Dorcalœmus candidolimbatus, sp. n.

♂ ♀.—Length, ♂ (1 specimen) 15·4 mm., ♀ (3 specimens) 13 to 15 mm.; width of head, ♂ 4·8 mm., ♀ 4·4 to 4·8 mm.; width of front of ♀ at vertex 0·6 to 0·75 mm.; distance from upper margin of occiput to anterior extremity of face, in ♂ 3·75 mm., in ♀ 3·3 to 3·75 mm.; length of proboscis, ♂ 10 mm., ♀ 8·25 to 8·75 mm.; length of wing, ♂ 12·5 mm., ♀ 12 to 12·6 mm.; greatest width of wing, ♂ 4·6 mm., ♀ 4·4 to 4·6 mm.

Head and thorax (at least in ♀*) as in foregoing species; dorsum of abdomen black, posterior angles of first segment ochraceous, sides of second segment more or less chestnut or tawny, hind borders of second, third and fourth segments clothed with shining silvery-white hair, hind borders of fifth and sixth segments in* ♀ *clothed more narrowly with shining orange-ochraceous (golden-yellow) hair, on sixth segment sometimes interrupted by black hairs in middle line, ground-colour of hind borders of all segments from first to sixth inclusive sometimes ochraceous-buff in* ♀*; wings and legs as in foregoing species, front tibiæ in* ♀ *sometimes brown at distal extremity and, except at extreme base, entirely brown or brownish on inside.*

Head: *palpi* and *proboscis* as in foregoing species; first and second joints of *antennæ* clove-brown, greyish pollinose, second joint sometimes rufescent, third joint wanting in all specimens available for examination. *Thorax*: hind margin of scutellum clothed with dark brown or black hair, ochre-yellow hair on dorsum mixed with brownish hair. *Abdomen*: dorsum clothed for most part with black hair; first segment sometimes with a greyish border surrounding black central area, posterior angles and hind border of this segment clothed with ochre-yellow hair; chestnut or tawny area on sides of second segment very conspicuous in some ♀ ♀, but in types of ♂ and ♀ so much reduced as to be scarcely visible, actual lateral margins in the ♂ being clove-brown or black; venter similar to dorsum, second segment in ♀ more or less ochraceous-rufous. *Squamæ* and *halteres* as in foregoing species.

Katanga, S.E. Congo Free State: Mid-Lualaba Valley, 3000 ft., 18–20. iv.1907 (*S. A. Neave*).

As indicated above at the end of the description of the foregoing species, *Dorcalœmus candidolimbatus* is closely allied to *D. auricomus*, from which it differs in the ♀ in the golden-yellow hair on the distal portion of the dorsum of the abdomen being confined to the hind margins of the fifth and sixth segments, and in the shining hair on the hind margins of the second, third, and fourth abdominal segments being silvery-white instead of golden-yellow.

Dorcalœmus compactus, Austen.

Pangonia compacta, Austen, Ann. Mag. Nat. Hist. ser. 8, vol. i, p. 212 (1908); Illustrations of African Blood-Sucking Flies, p. 61, plate iv, fig. 28 (1909).

The Diptera brought home by Mr. S. A. Neave include two ♀ ♀ of this species from North-Eastern Rhodesia—one from the Upper Luangwa Valley, 1800–2000 ft., 21.iii.1908, the other taken between Fort Jameson and Nyanji, 3000–3500 ft., 21.iv.1904. The latter specimen belongs to the subspecies *centralis* (*Pangonia compacta centralis*, Austen, Ann. Mag. Nat. Hist. *loc. cit.* p. 214) rather than to the typical form. Both individuals are now in the Hope Department of the Oxford University Museum.

Genus RHINOMYZA, Wied.

Rhinomyza umbraticola, sp. n. (Fig. 4.)

♀.—Length (13 specimens) 11·4 to 13 mm.; width of head 3·6 to 5 mm.; width of front at vertex 0·5 to 0·6 mm.; length of wing 11·25 to 12·8 mm.

Dorsum of thorax cinnamon, dorsum of abdomen ochraceous, with two rows of more or less distinct, transversely elongate, dark brown blotches; pleuræ, pectus, and ventral surface of abdomen ochraceous-buff; wings, as shown in Fig. 4, with a light brown or only moderately dark transverse band, a similarly coloured blotch occupying proximal half of each basal cell and proximal extremity of anal cell, and tip, from just beyond fork of third longitudinal vein, tinged with light sepia; legs ochraceous-buff, front tarsi brown, tips of joints of middle and hind tarsi light mummy-brown.

Head buff, occiput smoke-grey; *front* and *frontal callus* narrower than in *Rh. denticornis*, Wied., and other Ethiopian species of this genus; *frontal callus* raw-sienna-coloured, its upper extremity tawny; ocellar spot dark brown; lower surface of head clothed with mummy-brown or pale brownish hair; *palpi* buff, outer side of terminal joint darker (ochraceous-buff or tawny-ochraceous) and clothed with minute, appressed, black hairs, proximal joint clothed with brownish hair; first and second joints of *antennæ* raw-sienna-coloured, clothed with minute black hairs which become longer below, third joint darker, varying from ochraceous-buff to tawny, last two or more annuli of third joint mummy-brown, upper angle of second joint moderately produced, upper branch of third joint slender and tapering to a point (more slender than in *Rh. denticornis*, Wied.), lower branch much as in *Rh. denticornis* (less slender than in *Rh. perpulcra*, Austen), third joint about 1·6 mm. in length, its upper branch (measuring from base of joint) rather more than half as long. *Thorax* clothed on dorsum mainly with short brownish hair, and on pleuræ with pale yellowish, sometimes mixed with brownish hair. *Abdomen*: dark brown blotches on dorsum vary in size in different individuals, and when fully developed, as shown in fig. 4, occur on second to sixth segments inclusive; the blotches, which rest on

anterior margins of segments and are widely separated in median line, do not extend to lateral margins, and, in an antero-posterior direction, seldom reach so far as the middle of the segments; dorsum clothed for most part with minute, appressed, buff-yellow or orange-buff hair, but on sides of first and on basal angles of second segment with brownish, and on dark blotches with dark brown hair; venter buff or ochraceous-buff, unicolorous, clothed with minute, appressed, shining, buff-yellow hairs. *Wings*: costal cells raw-sienna-coloured; light blotch occupying distal extremity of wing usually connected with upper end of transverse band, but sometimes not. *Halteres*: knobs light mummy-brown, usually paler at distal extremity; stalks buff. *Legs* clothed for most part with brown or brownish hair.

Fig. 4.—*Rhinomyza umbraticola*, Austen, ♀. × 3.

North-Eastern Rhodesia and Katanga, S.E. Congo Free State: type and one other specimen from the high plateau south of Lake Tanganyika, 4500 ft., 26 and 22.viii.1908, type taken in "dense forest"; additional specimens from Mporokoso, N.E. Rhodesia, 4500 ft., 1.ix.1908; Chisinga Plateau, Kalungwisi district, N.E. Rhodesia, 4500 ft., 18–24.ix.1908; and Mid-Lualaba Valley, Katanga, S.E. Congo Free State, 3000 ft., 1.v.1907 (*S. A. Neave*).

With reference to the habitat of *Rh. umbraticola*, the following note has been supplied by Mr. Neave:—"This species seems to be confined to the neighbourhood, usually the interior, of patches of 'msitu,' *i. e.* areas of very dense forest, affording the deepest shade."

From all other African species of *Rhinomyza* at present known *Rh. umbraticola* can at once be distinguished by its spotted abdomen; it may also be noted that *Rh. maculata*, Surcouf, which occurs in Madagascar and has dark spots on the abdomen, differs from the species described above in having spotted wings.

A NEW SPECIES OF *TABANUS* FROM THE ANGLO-EGYPTIAN SUDAN.

By ERNEST E. AUSTEN.

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Tabanus kingi, sp. n. (Fig. 1.)

♀.—Length (four specimens) 13 to 16 mm.; width of head 4·4 to 5·5 mm.; width of front at vertex 0·5 mm. to just under 1 mm.; length of wing 10 to 13 mm.

Superficially somewhat resembling T. tæniola, *Pal. de Beauv., but distinguished by the more quadrate shape and blacker colour of the frontal callus* (cf. *fig.* 2), *the more ochraceous-rufous* colour and usually greater breadth of*

Fig. 1.—*Tabanus kingi*, Austen, ♀. × 3.

the proximal portion of the third joint of the antennæ, the absence of conspicuous longitudinal stripes on the dorsum of the thorax, the less clearly defined median stripe or median longitudinal series of lighter markings on the dorsum of the abdomen, by the presence of an appendix to the anterior branch of the third vein, and by the middle and posterior femora being fawn-coloured instead of slate-grey.—Dorsum of thorax mouse-grey, clothed with minute, appressed, buff-yellow mixed with minute black hairs; dorsum of abdomen tawny-ochraceous or ochraceous, with alternate longitudinal series of light and dark markings, last

* For names and illustrations of colours, see Ridgway, 'A Nomenclature of Colors for Naturalists' (Boston: Little, Brown, & Company, 1886).

two segments clove-brown; wings tinged with sepia, anterior branch of third longitudinal vein bent at an angle, with a backwardly directed stump or appendix.

Head light grey, occiput somewhat darker than face and jowls, front yellowish grey, of moderate breadth, inner margins of eyes parallel, a more or less faintly marked light mummy-brown horizontal band between base of each antenna and margin of eye on same side; *frontal callus* black or clove-brown, rectangular, broader than high; front clothed with short, erect, blackish hair, immediately above callus with yellowish hair, lower surface of head clothed with whitish hair; *palpi* cream-coloured, proximal joint clothed with whitish hair, terminal joint moderately swollen at base, then tapering to a point, clothed with minute, appressed, pale straw-yellow hairs, sometimes mixed in front with a few minute black hairs; first and second joints of *antennæ* ochraceous-buff, first joint clothed below with pale yellowish and above with minute black hairs, third joint ochraceous-rufous with dark brown distal extremity, expanded portion of third joint fairly broad, terminal

Fig. 2.—Heads of: *a*, *Tabanus kingi*, Austen, ♀, and *b*, *Tabanus tæniola*, P. de B., ♀.

annuli shorter than in *T. tæniola*, Pal. de Beauv. *Thorax*: dorsum with but a faint trace of paler longitudinal stripes; swelling in presutural depression on each side tinged with fawn-colour, and clothed with fairly long blackish hair; pleuræ and pectus grey or smoke-grey, clothed with whitish hair; *scutellum* agreeing with remainder of dorsum in coloration and hairy covering. *Abdomen*: dorsum marked as shown in fig. 1, except that the median pale greyish stripe, which is clothed with minute, appressed, yellowish hairs, is sometimes more distinctly composed of a series of truncate triangles; when abdomen is viewed at a low angle from behind, median stripe or truncate triangle on second (*i. e.* second visible) segment is seen to extend, like its successors, to front margin of segment; hind margin of first segment with a small patch of yellowish hairs in middle line; admedian stripes dark sepia-coloured, clothed, like dark patch near each lateral margin of each of the first five segments, with minute black hairs; each of first five segments with an elongate and somewhat ill-defined pale mark (clothed with minute

buff-yellow hairs) on each side of middle line, between admedian stripe and dark patch near lateral margin ; extreme lateral margins of first six segments clothed with whitish hair ; hind margins of fifth and sixth segments clothed for most part with yellowish hair ; sixth and seventh segments, except posterior and lateral margins of former, clothed with black hair ; *venter* ochraceous-buff, clothed with minute, appressed, straw-yellow hairs, hind margins of second to sixth segments inclusive cream-coloured or whitish, seventh segment entirely or for most part dark greyish-brown, clothed with erect black hair, sixth segment also with some black hairs in centre, fifth and sixth segments sometimes more or less infuscated, especially towards posterior and lateral margins. *Squamæ* isabella-coloured, with buff margins. *Halteres* ochraceous-buff, tips of knobs cream-coloured. *Legs* : coxæ olive-grey or smoke-grey, clothed with whitish hair ; rest of front legs black, except proximal halves, or rather less, of tibiæ, which are cream-coloured and clothed with minute, appressed, pale yellowish hairs ; outer side of front femora greyish pollinose, clothed with fine yellowish hair ; middle and hind femora fawn-coloured, clothed with pale yellowish hair ; middle and hind tibiæ buff, brownish at tips, clothed partly with black and partly with yellowish hair ; middle and hind tarsi dark brown, darker towards distal extremities.

Anglo-Egyptian Sudan : type and two other specimens from Khor Arbat, Red Sea Hills, 12.iv.1910 (*H. H. King*) ; an additional specimen bred from larva taken at same time and place (*H. H. King*).

Type in the British Museum (Natural History).

Mr. H. H. King, in whose honour this species is named, and whose description of its life-history will be found on pp. 269–274, states that he took seven specimens of *T. kingi* ovipositing on rocks overhanging a shallow, brackish stream, rippling over rocks and stones, and that two more were caught on camels.

Tabanus kingi is allied to an at present undescribed species of *Tabanus*, of which specimens from Abyssinia are contained in the British Museum collection. The Abyssinian species, however, which agrees with *T. kingi* in the shape of its frontal callus and in the anterior branch of the third vein being bent at an angle and provided with an appendix, is distinguished from it, at any rate in the female sex, by :—the frontal callus being dark mummy-brown instead of black or clove-brown ; by the much darker colour of the dorsal surface of the body ; by the dorsum of the thorax being distinctly striped, and clothed mainly with black instead of with buff-yellow hair ; by the series of pale marks on the dorsum of the abdomen, outside the admedian stripes, taking the form of clearly defined light grey spots, which are distinctly ovate in shape ; and by the ground-colour of all the femora, and not merely of those of the front legs, being black.

A NEW SPECIES OF TSETSE-FLY ALLIED TO *GLOSSINA PALPALIS*, ROB.-DESV.

By ERNEST E. AUSTEN.

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Glossina caliginea, sp. n.

♂ ♀. Length, ♂ (15 specimens) 8 to 8·5 mm.*, ♀ (15 specimens) 9 to 10 mm.; width of head 2·8 to 3 mm.; width of front at vertex, ♂ 0·75 mm., ♀ 1 mm.; length of wing, ♂ 8 to 8·75 mm., ♀ 9·4 to 10 mm.

Allied to and resembling Glossina palpalis, *Rob.-Desv., but browner, and usually somewhat larger; head distinctly broader, front if anything slightly narrower, at least in ♂; dark portion of dorsal surface of abdomen browner (dark sepia-brown, instead of clove-brown or blackish-brown), paler area on second segment, instead of being confined to a, usually narrow, median triangle, broad and more or less quadrate or irregular in outline, its lateral margins being generally ill-defined; hypopygium of ♂ buff or ochraceous-buff, instead of grey as in typical* G. palpalis; *pollinose dorsum of seventh abdominal segment in both sexes often cream-buff, and consequently yellower than in* G. palpalis; *extreme hind margins of preceding segments (except posterior angles) never lighter.*

Head: *face*, *jowls*, and *occiput* coloured as in *G. palpalis*, but sides of face (parafacials) slightly narrower, and jowls not descending so much posteriorly (*i. e.* lower margin of eye nearer to lower margin of head on each side); *frontal stripe* chestnut; frontal margins (sides of front or parafrontals) varying from light mouse-grey to olive, often darker than in *G. palpalis*, showing, as in the latter species, a dark brown elongated area below when viewed from the side; ocellar triangle drab-grey or mouse-grey, ocellar spot and dark brown band uniting vertical bristles as in foregoing species; *antennæ* mouse-grey, narrowly cream-buff at apex of second joint and extreme base of third joint on outer side, anterior and posterior edges of third joint in both sexes without a long and conspicuous fringe of fine pale hair † (*cf.* figs. 1 and 3), and its distal extremity only moderately prominent, *arista* distinctly *longer* and *more slender* (tapering off less abruptly) than in

* A specimen in the Museum collection with its abdomen distended by coagulated blood measures 9·4 mm. in length.

† There is a fringe on the third joint of the antennæ, but it is so short and the hairs composing it are so minute as to be scarcely noticeable when the joint is examined in profile under an ordinary platyscopic lens.

G. palpalis (*cf.* figs. 1 and 2) ; *palpi* mouse-grey, darker above and towards distal extremity.

Thorax: dorsum with dark brown markings of same type as in typical form of *G. palpalis*, but often somewhat more extensive ; pleuræ and interspace between markings on dorsum light mouse-grey ; *scutellum*, at least

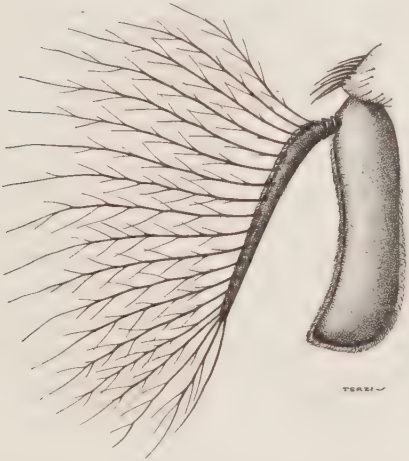


Fig. 1.
Antenna of *Glossina caliginea*, Austen.
× 30.

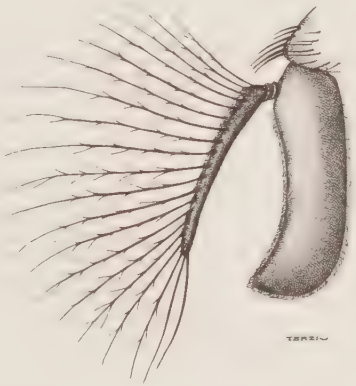


Fig. 2.
Antenna of *Glossina palpalis*, Rob.-Desv.
× 30.

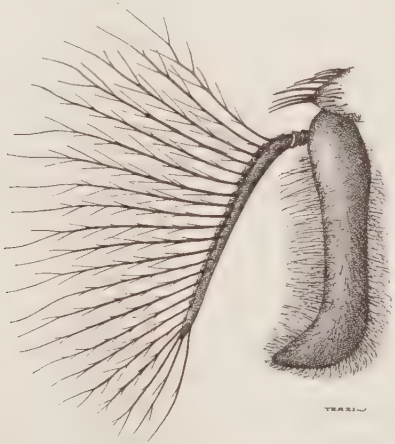


Fig. 3.—Antenna of *Glossina pallicera*, Bigot. ×30.

in ♀, somewhat more elongate than in *G. palpalis*, apical scutellar bristles in ♀ unusually short, reduced to small spines, hind margin of scutellum and interspace between distal extremities of dark blotches on dorsum cream-buff.

Abdomen: first segment cream-buff or buff, with a dusky (dark grey) patch on each side; dorsum of second to sixth segments inclusive dark sepia-brown; median paler region on dorsum of second segment cream-buff to ochraceous-buff or pale cinnamon, the central lanceolate area enclosed within the usual admedian grooves exhibited by this segment often paler than the region outside the grooves; one or more of the four segments following the second usually with a paler (buff, ochraceous-buff, or cinnamon-coloured) median area on the dorsal surface; in some specimens the third and fourth, third to the fifth, or even the third to the sixth segments each show a narrow paler median longitudinal streak, which usually fails to reach the hind margin of each segment: in others the paler area on the third segment, or on the third and fourth segments, is as broad as that on the second, while on subsequent segments the paler area is reduced to a streak; lateral margins and posterior angles of second to sixth segments inclusive smoke-grey, scarcely visible from above; pollinose dorsum of seventh segment varying from smoke-grey to cream-buff or buff, often infuscated at base in ♀; *hypopygium* of ♂ resembling that of *G. palpalis*, Rob.-Desv., in shape, but somewhat larger, and, as seen by careful examination from the ventral side, *somewhat squarer* (*i. e.* its posterior margin not quite so much rounded off).

Legs ochraceous-buff; coxæ buff, outer surface of front coxæ blotched with dark grey; femora, especially front pair, blotched or streaked with dark grey or greyish-brown, front femora often almost entirely dark mouse-grey; last two joints of front and middle tarsi tipped with dark brown; hind tarsi entirely blackish-brown above.

Wings uniformly sepia-brown, fairly dark. *Squamæ* light cream-coloured; antisquama hyaline, its fringe brownish. *Halteres* cream-buff.

The typical specimens of this species are a ♂ and ♀ from Southern Nigeria, in the British Museum (Natural History), both taken by *Mr. G. Garden*, Veterinary Officer, S. Nigeria,—the ♂ on a creek near Akitipupu, 18.v.1909, the ♀ in a canoe on a creek between Aro Chuku and Itu, 16.iii.1909.

Distribution of *G. caligined*, sp. n.

Up to the present time, this species has been received only from Southern Nigeria. In addition to the types of the ♂ and ♀, the following specimens are contained in the Museum collection:—1 ♂, Benin (*A. Millson*); 1 ♂, Benin City, 18.iii.1910, and 1 ♂, Forcados, 30.iv.1910 (*J. J. Simpson*: presented by the Entomological Research Committee); 1 ♂, Sobo Plains, July, 1904, and 1 ♀, Sapele (*Dr. G. F. Darker*); 1 ♂, 1 ♀, Owa River, Lagos, August, 1904 (*Dr. W. H. W. Strachan, C.M.G.*); 1 ♂, 2 ♀ ♀, Oni River, 70 miles east of Lagos, 2, 9, and 29.v.1910 (*Dr. W. A. Lamborn*: presented by the Entomological Research Committee); 1 ♂, 3 ♀ ♀, between

Aro Chuku and Itu, "caught in canoe on creek," 16.iii.1909; 2 ♂♂, 1 ♀, between Agbabu and Akitipupu, "caught in canoe on creek," 17 and 19.v.1909; and 2 ♂♂, 1 ♀, on creek near Akitipupu, 18.v.1909 (*G. Garden*); 1 ♀, Old Calabar, 14.v.1900 (*Dr. H. E. Annett*). The following specimens, in the possession of the Entomological Research Committee (Tropical Africa), have also been examined:—3 ♂♂, 4 ♀♀, Oni River, 2, 4, and 9.v.1910 (*Dr. W. A. Lamborn*).

Habits, etc.

Glossina caliginea, which, from the data printed above, would appear to be prevalent in parts of Southern Nigeria in the month of May, is evidently prone to attack travellers in canoes. This has been observed both by Mr. Garden and Dr. Lamborn, the former of whom, with reference to the specimens taken by him in a canoe on a creek between Agbabu and Akitipupu, on May 17 and 19, 1909, contributes the interesting note that the flies "attacked during heavy rain"; Mr. Garden also states that at the spot at which the flies were encountered there was "dense cover," consisting of "long grass and water-plants." One of Dr. Lamborn's specimens (a male, taken on the Oni River, on May 9, 1910) bears the following field-note:—"As I was going up river in a canoe at 3.0 p.m., this insect bit me on the arm, and became so distended with my blood that it was unable to fly away." A female in the possession of the Entomological Research Committee, taken by the same collector on the same river and date, bears the label:—"From European's back and distended with his blood, while canoeing up river." A male and female from Dr. Lamborn, caught on May 4, 1910, are labelled as being "off European's clothes, while journeying up river in a canoe"; and the remaining specimens of this species received from the same source by the Entomological Research Committee are also stated to have been caught on a European's clothes.

Affinities and Distinctive Characters.

Among the group of species with dark hind tarsi constituted by *Glossina palpalis*, Rob.-Desv., *G. pallicera*, Bigot, *G. caliginea*, Austen, and *G. tachinoides*, Westw., the new species can only be confused with the two first mentioned. Care is necessary at the outset in order to distinguish *G. caliginea* from *G. palpalis*, but the very real differences between the two species have been pointed out in the course of the foregoing description. The darker hue and usually larger size of *G. caliginea*, combined with the characters supplied by the third joint of the antennæ (dusky coloration, stouter shape, less prominent distal extremity, and especially the absence of a conspicuous fringe of pale hair on the anterior and posterior edges—*see* figs. 1 and 3), will suffice to differentiate the new species from *G. pallicera*.

NOTES ON *GLOSSINA FUSCA*, WALK., IN NORTH NYASA.

By Dr. MEREDITH SANDERSON,
Medical Officer, Nyasaland Protectorate.

(Map.)

The following notes are based on observations made during the months of June and July, in and near the Songwe valley.

Between Karonga and the River Songwe the country consists of a plain about 10 miles in width, lying between Lake Nyasa and an irregular line of foot-hills, behind which the country becomes more and more hilly, gradually rising to the Misuko Hills, some thousands of feet above sea-level.

The plain (1) * is open, *i. e.*, it is covered with long grass and a few small trees, and is crossed by numerous rivers and streams rising from the hills and running into the lake. All these streams are marked throughout their course by narrow lines of thick bush and large trees, usually including a few palms, but not invariably (fig. 1, p. 300). *G. fusca* was found in the bush on all these streams, though many of them are dry or are represented by a few stagnant pools only, at this time of the year. No fly was found on the plain, though the natives state that it is very prevalent there also during the rains (*i. e.* about January).

For the first few miles up the Songwe the character of the country is very similar, and *G. fusca* was found on the river and on all its tributaries. On leaving the plain, however, and entering the Songwe valley, the wooded hills gradually close in near the river, so that the open spaces of the plains are soon altogether absent, and the bush is continuous between the streams running into the Songwe (2). The trees, however, are smaller, and the brush-wood almost absent, being replaced by coarse grass, brambles, etc. Here in the course of every stream, however small and however dry, this species of *Glossina* was found, frequently in very large numbers, and the fly could be observed in almost any sheltered spot. They were, in this locality, invariably absent from places where the trees were thin, or where they were not protected from sun and wind. They were also found in the rank bush bordering the main river.

Towards Nkana the trees on the hills become scarcer, the hills are bigger and the valleys between them deeper, and *G. fusca* became difficult to find (3). At the River Makeye there is a wide valley with long grass and few trees, and

* These numbers will be found on the map, indicating the localities referred to.

the banks of the Songwe are of a similar nature. Here the fly was found in two places only, one some miles up the valley of the Makeye in a belt of trees about half a mile from that river, and the other on the Songwe in the long grass. The latter habitat is a very exceptional one, and only two specimens were seen on this occasion.

Beyond the Makeye the hills became bigger and the Songwe is fed by torrents, while the banks of the river are impassable owing to long grass, scrub, etc. (4). No fly was found in these hills, nor at the few places where it was possible to approach the Songwe. Near Mugofi Hill the Songwe was carefully searched for some distance. Above this the river runs through mountainous country, offering no shelter to the fly, and none was found.

Fig. 1.—Mawerela Stream, North Nyasa (see Map). The course of the stream is indicated by the narrow line of bush along its banks, the adjoining country being open and covered with long grass.

The higher reaches of the Makeye, Chungu, Kaporo, and Lufira rivers were then searched, but without success, presumably owing to the absence of trees and to the elevation. With regard to the latter, no very definite conclusions can be drawn, as in one instance, on the Karambu stream (5), *G. fusca* was found in considerable numbers near the top of a hill some 700 feet above Songwe level, here about 1700 ft. above sea-level,—at a height therefore of about 2400 ft.; this was about 3 miles distant from the Songwe.

The fly is on the wing and is desirous of feeding at two periods of the day

only, viz. :—in the early morning and in the evening ; between 8 a.m. and 4 p.m. their presence would be entirely unsuspected, though an isolated specimen might be caught after very careful search. They were found during the day under leaves of bushes or in the grass, always near the ground (*cf.* fig. 2). They continued to bite and could be heard flying about for some time after dark. At these times, the morning and evening, they were frequently present in large numbers, and 20 to 30 specimens could be caught with one net in the course of an hour. Two specimens were caught *in coitu* ; they were found on the trunk of a large tree, at a height of about 4 feet, at about 5 o'clock the evening.

Fig. 2.—The narrow, dried-up bed of the Mawerela Stream, showing how it is overgrown with dense bush, in the deep shade of which *Glossina fusca* is found during the day.

At a village on the Ponga stream (6) the cattle were found to be infected with trypanosomiasis, suggestive of Nagana, the trypanosomes having the morphological characters of *Trypanosoma brucei*. *G. fusca* was found in exceptionally large numbers, and two specimens were caught in the hut in which an infected cow was lying, and which was also the living-place of its owners. This is the only time that I have succeeded in finding the fly actually in a village. I hope to investigate this trypanosomiasis later on.

The grass and scrub in this part of the country is burnt in November and December.

The flies bite through dark clothes, but have never been seen to settle on

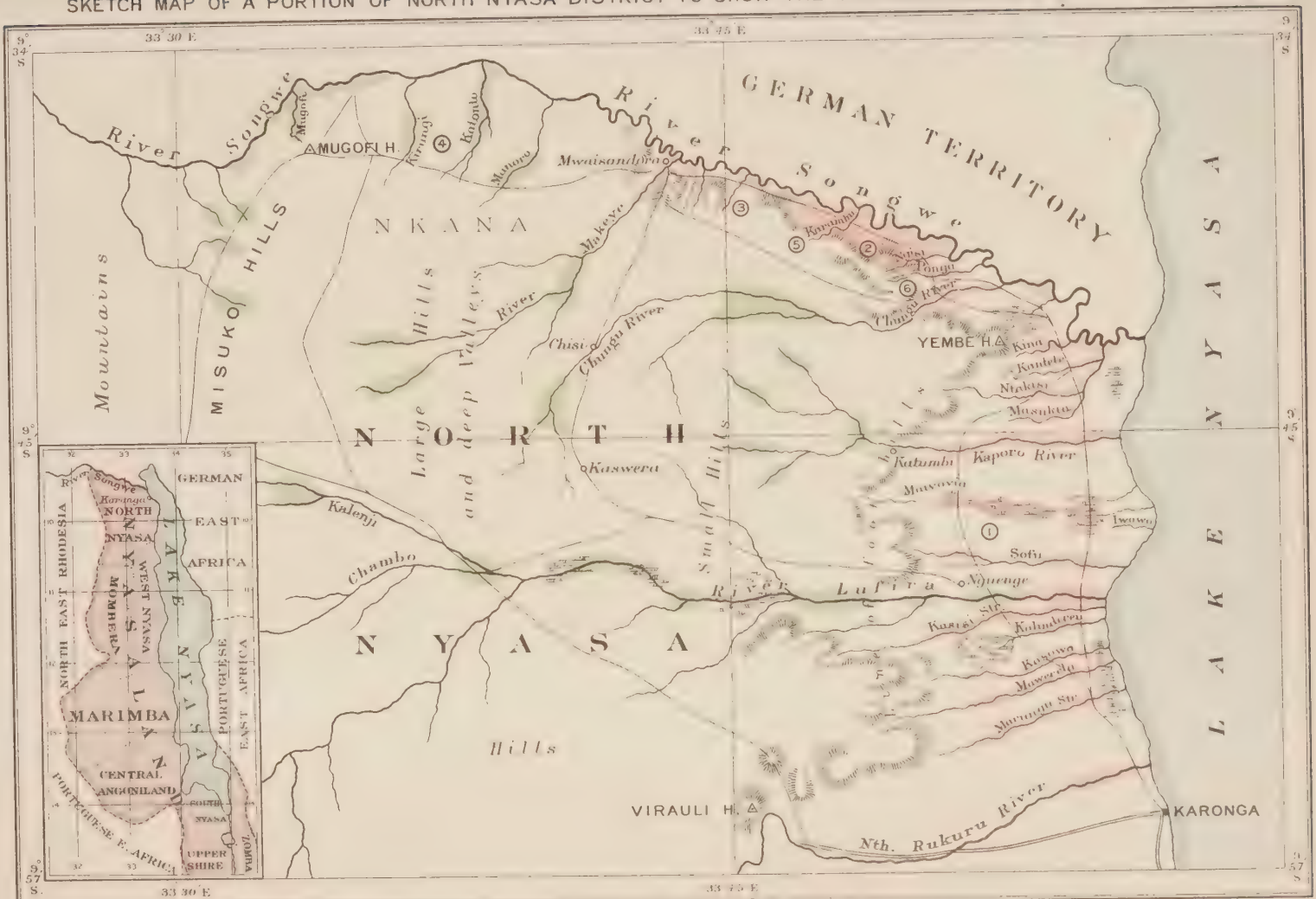
white surfaces. I have not observed any natural enemies, nor have I seen the fly drinking.

Cattle are kept in large herds over the whole of the country above described, and I have observed them being bitten when being watered at many of the rivers. The cattle infected with Nagana (?) at the Ponga are said to have come from the Chungu, less than a mile distant, where there are large herds apparently quite healthy, though I have seen them being bitten by *G. fusca*.

There is a history of all the cattle having died off in two places, at one of which, Katumbi on the Kaporo River, no attempt has since been made to keep them; at the other, Mwaisandoro, on the Makeye, there are at present a number of cattle, apparently healthy. *G. fusca* was found at both places.

A few isolated cases of Sleeping Sickness have been found in Nyasaland, one in this District, but none in the part described above.

SKETCH MAP OF A PORTION OF NORTH NYASA DISTRICT TO SHOW THE DISTRIBUTION OF GLOSSINA FUSCA.



Swamps
(Under water 8 months in the year.)

Scale 1/312,000 or 1·014 Inches to 5 Miles

G. fusca found.
G. fusca looked for, but not found .....

REPORT ON A JOURNEY TO THE LUANGWA VALLEY, NORTH-EASTERN RHODESIA, FROM JULY TO SEPTEMBER, 1910.

By S. A. NEAVE, M.A., B.Sc.

(Map.)

Itinerary.

Leaving Karonga, at the northern end of Lake Nyasa, on July 15th, I reached Katumbi on the Luwumbu River, the chief tributary of the Upper Luangwa, about a week later. I had made this river my objective, as I had already examined, in 1908, a considerable portion of the Luangwa above its junction with the Luwumbu. After following the Luwumbu down to this point, the Luangwa itself was followed for a considerable distance, chiefly on the left bank.

I crossed to the right bank a little above the mouth of the Mwailesi River, and after following the Luangwa for some 30 miles further, I temporarily left it and proceeded westward to the Nyamadzi River, in the valley of which three cases of Sleeping Sickness were discovered by Dr. Leach some months ago. Unfortunately, I did not receive information as to the position of the villages in which these cases were found, in time to do more than make a special search in the vicinity of one of them. I examined, however, a portion of the Nyamadzi River in the vicinity of Nawalia, as also the lower portion of the Mpamadzi River further south. The evidence as to the existence of *Glossina palpalis* or *G. fusca* on these rivers was negative. The locality seemed, however, a not unlikely one for the latter species and not altogether unsuitable for the former. At the same time, the amount of cover and shade on the banks of these rivers is considerably less than on a typical *palpalis* river of the same size in the Congo basin. It would appear probable that the amount of shade required for the well-being of the species varies with the climatic conditions and the volume of water present ; so that heavier shade would be required in a relatively drier country.

It is possible that *G. fusca* occurs in this locality, but in such small numbers at the time the visit was made—viz., at the height of the dry season—that it was overlooked. At the same time, Dr. Leach, whose visit was made during the rains, does not appear to have met with it either.

It may be noted that these Western tributaries of the Luangwa differ considerably from those of the Eastern side of the valley. They take their rise on the lofty Mchinga escarpment, and the larger ones among them are permanent running streams. Indeed, but for the Mwailesi, Nyamadzi, and Mpamadzi, the Luangwa would itself be dry for many months of the year.

On the other hand, on the eastern side of the valley the tributary streams which rise on the comparatively low watershed between North-Eastern

Rhodesia and Nyasaland are of a very different character. From the Luwumbu River southward there is practically no running water for several months of the year, except quite near the watershed. The only water to be found is in pits and pools in the sandy river-beds.

From the Mpamadzi River the Luangwa was followed, sometimes on one bank sometimes on the other, to a point about 25 miles below Hargreaves (Chutika). As time was valuable it did not seem advisable to go beyond that point, more especially as Dr. Leach and Mr. Silverlock have recently been over that part of the ground and are now, I understand, on their way back.

Fig. 1.—Characteristic view of the Luangwa River, with a sand-bank on one side and a steep alluvial bank, being gradually eroded, on the other.

From the Luangwa I returned to Petauke, visiting *en route* several points on the main road east of Hargreaves. From Petauke, after visiting the camp for sleeping sickness patients, a little to the south of that place, I proceeded direct to Fort Jameson.

Of the general features of the Luangwa Valley I have given some account in a recent paper *. A good account of the character of the banks of the Luangwa is also given in Dr. Leach's last report. A map and a few photographs of some characteristic Luangwa Valley scenery are also sent herewith.

* Journal of the Royal Geographical Society, 1910, pp. 133–136.

Notes on the chief Biting Insects and Ticks met with in the Luangwa Valley.

Glossina palpalis appears to be absent from the whole valley. It is decidedly doubtful whether this species could survive in this locality, even if introduced there. We know, from the work of Roubaud and others, that a very considerable degree of atmospheric humidity is necessary for the well-being of this species. Now the Luangwa Valley is notorious, locally at least, for being intensely dry, as well as being extremely hot. This condition of things obtains during the greater part of the six months of the dry season

Fig. 2.—A sand-bank in the bed of the Mid Luangwa River.

and even at intervals in the wet season, the rainfall being relatively small. Apart therefore from considerations of geographical distribution and the influence of the high ground of the Congo-Zambesi watershed, which I have pointed out elsewhere*, it would seem that the climatic conditions are unsuitable for *G. palpalis*.

For an account of the dry character of the Luangwa Valley, and of the causes thereof, reference may be made to a paper by Mr. L. A. Wallace in the Journal of the Royal Geographical Society, April 1907, p. 382 *seq.*

Even supposing the adult fly could survive the long and intensely hot dry

* Journal of Economic Biology, 1909, vol. iv. pt. 4, pp. 109–114.

season, it is difficult to see where suitable breeding grounds could occur. I cannot agree with Dr. Leach's suggestion that the fly might migrate in the wet season to the smaller streams in search of suitable breeding grounds; for the banks of such streams at this time are liable to even more sudden and violent inundations than those of the larger rivers.

It must be remembered that practically the whole of the low ground in the Luangwa Valley is covered with deep alluvial soil, generally of a sandy nature, in which the rivers at time of flood cut deep and frequently shifting channels.

Glossina morsitans calls for comparatively little comment. It is practically ubiquitous on both sides of the valley, southward from a point approximately level with the junction of the Luwumbu River. A phenomenon observed by the author on the south-west shore of Lake Nyasa was also noticeable here—namely, that the fly rather avoids, than otherwise, the immediate vicinity of the river or lake, though generally abundant enough half a mile or less inland. The insect of course frequently follows man or animals to the bank, but is, I think, seldom resident there.

There can be no doubt whatever that *G. morsitans* has spread enormously within the last five years in the Luangwa Valley. The author visited one or two localities in the Petauke district where this species is now swarming, but where it was certainly not present when he was there in 1904 and 1905*. There appears to be, however, a general consensus of opinion among the older natives that in these cases it is not really invading new areas, but is recovering the ground lost at the time of the rinderpest, some fourteen years ago.

Glossina fusca.—The history of the few specimens of this species discovered to date appears to be as follows:—

In December 1904, or January 1905, the writer obtained a single specimen close to Hargreaves. This specimen is now in the Hope Department, Oxford University Museum.

On arriving at this locality on the present trip, in the month of September, the writer was informed by Mr. C. R. Rennie, the Acting Assistant Magistrate at Petauke, that he had obtained through natives a few specimens in two other localities in the same district:—

(1) On the Chirimanyama stream at the point where the main road crosses it, and about eight miles west by south of Hargreaves. This stream is running all the year at this point.

* [Mr. E. E. Austen has in his possession a letter written by Mr. Chesnaye in December 1903, and another written by Mr. H. Thornicroft (Native Commissioner, Petauke) in May 1904, in both of which reference is made to the occurrence at that time of *G. morsitans* at Molilo's village and between Petauke and the Nyimba River. The late Mr. Codrington also sent to the British Museum several specimens of this species which were captured in these localities in June 1904.—Ed.]

(2) On the Kanga stream, also at the point where it is crossed by the main road from Petauke, and some eight or nine miles east of Hargreaves.

The writer failed to find any specimens at Hargreaves itself on this occasion, nor did he find any on the Chirimanyama after a most careful search, at a place some two miles below the point where the road crosses, in spite of the fact that the conditions seemed favourable and running water was present.

On the Kanga stream the writer took a single specimen just after sunset at a point about half a mile above the road where there was still a trickle of running water. The specimens captured by Mr. Rennie's natives were taken

Fig. 3.—Characteristic mopani forest: this would be flooded in the wet season.

more than a month earlier, and it is of interest to note that two at least were taken below the road close to a considerable pool of stagnant water which had dried up at the time of the author's visit. The single specimen taken on the present occasion was the sole result of a rigorous search by the author and several trained natives from 3 p.m. until dark. The previous month it had taken an even larger number of natives three whole days to capture five specimens. These were also, I understand, taken toward sunset.

On the following day the author took another individual, at about 10 a.m.,

within a few hundred yards of Molilo's big village, some six miles further east. In spite of a prolonged search until after sunset on the same day, not a single other specimen was even seen. In this locality there was no actual running water, though the spot was an exceptionally damp and cool one, there being a quantity of dense shade in the immediate neighbourhood.

Fig. 4.—A small pool near the Luangwa, at the end of July; this would be dry from September to November.

It would appear that *G. fusca* in the dry season, at least, frequents the tributary streams of the Luangwa rather than the banks of the main river, which have wide sand-banks and belts of reeds separating them from the water's edge, and perhaps do not provide sufficient shelter from the scorching sun of this locality. I am inclined to attribute the presence of my original specimen of *G. fusca* at Hargreaves, in the wet season, to the fact that a fair-sized stream, the Mvuvia (of which the above mentioned Kanga is

itself a tributary), enters the Luangwa at this point *. Though this stream dries up in the dry season, there is a small spring in its bed close to Hargreaves.

Since writing the above, I have received a note from Mr. Rennie, that a single specimen of *G. fusca* has been taken biting a native on the banks of this stream at Hargreaves. The time of day is not stated.

I think it probable that this species will be found in small numbers during the rains on most of the tributary streams and perhaps on the main river itself. That it can be at all abundant even at this season seems unlikely, as

Fig. 5.—Rocky bed of Southern Nyamalzi River, south of the Mvuvia River, Lower Luangwa Valley.

it does not seem to have been observed by either Dr. Leach or Mr. Silverlock at that time of year. Dr. Kinghorn, who visited this place, I believe, about June, 1907, does not seem to have met with it either.

This species would appear to retire up the streams with the advance of the dry season, and at the hottest and driest time it seems to be found only

* Previously published maps are incorrect in this particular, as the Mvuvia does not enter the Luangwa some miles below Hargreaves, as there depicted, but at a point only some 200 yards above it.

near the sources where there is running water or at least considerable pools in the bed of the stream.

Further work in mapping the distribution of *G. fusca* in the Luangwa Valley is urgently required, especially during the wet season. Besides the tributary streams around, and perhaps above, Hargreaves, I am inclined to think that this species may also occur in the valley of the Lukashashi River to the west, where the conditions of elevation etc. are very similar.

Of the other biting flies the TABANIDÆ were, as usual, by far the most numerous, and a fine series was obtained, amounting to over 1500 specimens,

Fig. 6.—Mopani forest, with young zebra.

nearly all of which were collected at the damp mud and sand at the edges of the small pools which constitute the only water remaining in the smaller streams at this season; these pools being often only a few yards across and a few inches deep.

From the middle of July until September 1st very few individuals of the genus *Tabanus*, and no *Hæmatopota*, were taken in the Luangwa Valley; but some days later very large numbers of several species made their appearance.

It must be remembered that at the time of writing (mid September) the dry season, which is very marked in the low ground of the Luangwa Valley, is nearly at its height, and the first rains are due in from five to six weeks time. The first signs of spring, obvious enough on the high and cool plateau, are hardly discernible on the low ground. The appearance of TABANIDÆ in this locality would however appear to coincide with that of the same or allied species elsewhere irrespective of elevation.

Though a few isolated individuals have been taken on the banks of the

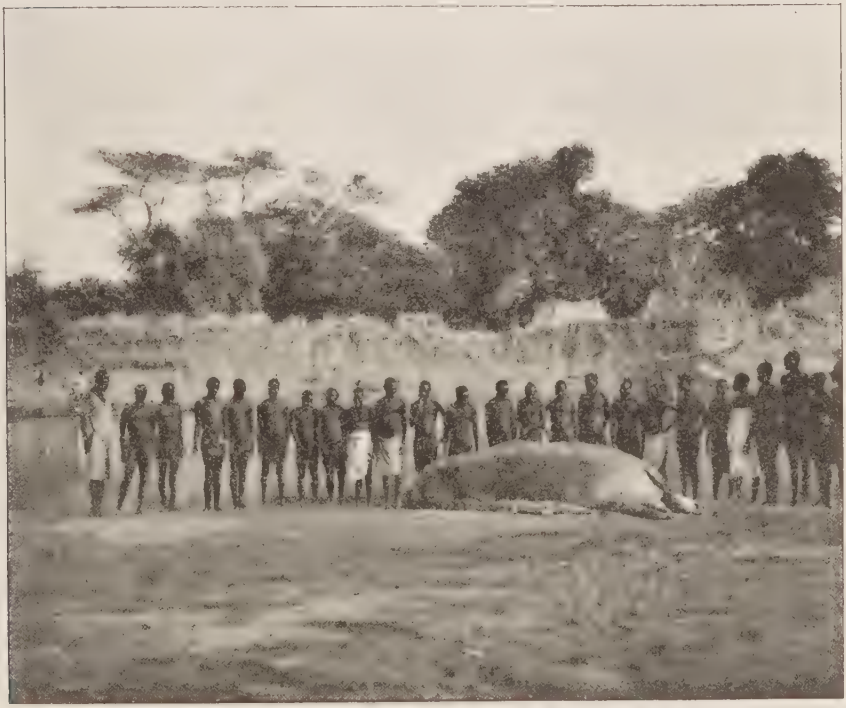


Fig. 7.—Natives, with hippopotamus and crocodile, Luangwa River; the author's camp in the background.

Luangwa River itself, the vast majority are to be found in the neighbourhood of the tributary streams and lagoons, now fast drying up, in which they have no doubt spent their larval stages.

During the hottest hours of the day numbers of both sexes (the males however being in the majority) are to be found round the pools referred to above, drinking at the damp sand or settled on the reeds near the water's edge. Some of the more fragile and slender species, such as *T. gratus* and a species allied to *T. ditæniatus*, seemed to be able to drink by alighting on

the surface of the water with outstretched wings and passing their proboscis through the surface film. I am inclined to attribute the large number of males (often far exceeding that of the females) to the fact that they had hatched in the neighbourhood and had not strayed far from it, whilst the females had begun to scatter in search of vertebrate blood. I am also inclined to attribute the great scarcity of the males in collections to the fact that they are probably very short-lived compared with the females, and that unless one is fortunate enough to be on the spot soon after their emergence from the pupal state, one fails to find them at all.

It is also worthy of note that in these localities, perhaps owing to their recent emergence, even the females did not seem much inclined to search for food or to bite. On the Lusangazi River, where in three days I captured with the help of natives nearly 300 individuals of 11 species, not a single one entered my tent, though it is usually a most attractive place for *Tabani* and was situated not more than fifty yards from the water-holes. Perhaps the deep shade in which it was placed acted as a deterrent.

I do not wish to suggest that these insects are really more common on the tributaries of the Luangwa than on the main river, but merely that their drinking, and perhaps breeding places being more concentrated and localised they are much easier to find in quantity.

The following are some particulars of the species obtained up to the present date, the identifications being only tentative:—

1. *Tabanus tæniola* and var. *variatus* (111 ♂♂, 62 ♀♀). This species is widely distributed and has been taken in every locality.

2. *T. fraternus* (1 ♂, 2 ♀♀). This seems to be a rare species.

3. *T. ? nyassæ* (3 ♂♂, 2 ♀♀).

4. *T. biguttatus* (20 ♂♂, 8 ♀♀). Very widely distributed, but nowhere met with in very large numbers.

5. *T. maculatissimus* (3 ♂♂, 1 ♀). Up to the present observed in only one locality.

6. A small black and white species, near *T. insignis* (7 ♂♂, 2 ♀♀).

7. *T. gratus* (12 ♂♂, 6 ♀♀).

8. *Tabanus* sp., near *ditæniatus* (11 ♂♂, 138 ♀♀).

9. *T. thoracinus* (1 ♂, 2 ♀♀).

10. *Tabanus* sp. (83 ♂♂, 12 ♀♀). A robustly built species of medium, or rather below medium, size; black, with rows of spots of a bluish grey. The female's wing is much darker than that of the male.

11. *Tabanus* sp., near *rothschildi*. Both sexes taken in large numbers; it seemed to frequent the water-holes at nearly every native village. The females were exceptionally voracious.

12. *T. ustus*. A good series was taken of both sexes.

13. *Tabanus* sp., near *denshamii* (1 ♂, 1 ♀).

14. *Tabanus* sp., near *gratus* (2 ♂ ♂).
15. *T. insignis* (1 ♂).
16. *T. sharpei* (1 ♂).
17. *Tabanus* sp. (4 ♂ ♂).
18. *Tabanus* sp. (5 ♂ ♂).

It will thus be seen that I have been fortunate enough to obtain the males of all the 18 species collected.

One, perhaps two, species of *Hæmatopota* have been taken; the males being in the majority.

A single species of the genus *Chrysops*, near, if not identical with *C. longicornis*, was found in one locality. The three specimens taken (females) were all biting the shins and ankles of natives.

Two or more species of *Stomoxys* were obtained, though the genus is relatively scarce and local in the Luangwa Valley, compared with the high ground on either side. On two occasions when eland were shot about sunset a relatively very large species, resembling *S. nigra* except in size, was taken settling upon them.

Hippobosca maculata was collected on several occasions on the common waterbuck, *Cobus ellipsiprymnus*, but only on that species. All the three individuals captured on one antelope seem to belong to a distinct immaculate form, though another antelope in the vicinity had normal specimens in its coat.

A species of (?) *Lipoptena* was taken in small numbers on bushbuck and kudu.

Besides a few mosquitos, which are always scarce in the Luangwa Valley in the dry season, I took one, perhaps two, species of *Phlebotomus*. I found these widely distributed in the shadier and damper spots over the middle and lower part of the valley. The specimens were mostly taken at night, and I cannot say I found them very voracious; in fact I was not conscious of having been bitten at all.

With regard to biting organisms in the native huts, a floor-maggot is very common in any hut not kept very clean. A number of the adult flies were taken, apparently belonging to the common species *Auchmeromyia luteola*. I also captured two individuals of a relatively enormous species which, except in size, closely resembles the last, and which is alleged by the natives to have a similar life-history.

A species of *Clinocoris* (*Cimex*) is ubiquitous, occurring in almost every hut in the country.

Ornithodoros moubata appears to be nearly absent from the low ground in the Luangwa Valley, though common enough on the high ground on either side. The only place anywhere near the river where I met with this species was in some shelters on the cotton plantations at Hargreaves, occupied by some Angoni natives from the high ground of the Rhodesia-Nyasaland

watershed. These natives had only arrived a month before and had almost certainly introduced this species, since it was absent from the local villages.

There is also a cockroach, of which a few specimens were obtained, and which is widely alleged by natives to bite with some severity. This is a surprising fact, if correct: though it would appear very doubtful whether these insects draw blood, it is confidently asserted by natives that they produce a small but definite wound in the skin. This insect is locally known as "Nianduli," and appears to be less common near the Luangwa River than on the higher ground. At this place, Fort Jameson, it is not uncommon and is well known to the natives. A considerable collection of ticks, fleas, lice, etc. from various vertebrate hosts was also made.

Summary and Conclusions.

We have considerable justification for excluding *G. palpalis* as the cause of the cases of Sleeping Sickness in the Luangwa Valley. This region has been now so carefully searched by so many independent observers at all seasons of the year, that, quite apart from all climatic considerations etc., it is hardly possible that *G. palpalis* can have been overlooked. This being the case, all classes of biting organisms must fall under suspicion.

The cases found in the Luangwa Valley by Dr. Leach and their histories have appeared in full in that officer's reports. I visited the sites of most of the villages of these cases and managed to elicit a few additional points.

I found that, of the three cases found by Dr. Leach in the valley of the Nyamadzi, two were youths and the third, though adult, was unmarried. This would imply that when in their villages they would sleep in the "bachelors" hut. Owing to the fact that this hut is not looked after by a woman, it is nearly always neglected and dirty, and is almost certain to harbour floor-maggots, Clinocoridæ (Cimicidæ) or any other biting organisms there may be in the village. It is also this hut, if any, which is used for accommodating travellers.

For the reasons stated above, I was able to visit the village of only one of the three cases, viz., that of case No. 3 recorded in the Nyasaland Sleeping Sickness Diary, part x, p. 4. This man's village is situated on the right bank of the Nyamadzi on the main road about 4 miles below Nawalia. The chief admitted that the infected native, a youth named Bunyunga, slept in the boys' common hut, and that this hut was frequently accommodating travellers, Government police, Messengers, etc., passing up and down the main road.

The only point that the seven cases in the Petauke district would appear to have in common is that they either live near Hargreaves or have more or less frequently visited that place. Too much importance must not, I think, be attached to the fact that all the cases were found on or near the banks of the

Luangwa, since most of the inland villages in the neighbourhood remain to be examined.

Four or more cases, of which details are not yet to hand, have just been discovered in the country to the north of Fort Jameson near Chinunda, on or near the main road.

There would thus seem to be definite centres of infection associated with the main roads. This does not altogether exclude *Glossina morsitans*, though it is neither more nor less abundant in these localities than elsewhere in the valley, since it might not yet have had time to become infected at a distance from these main roads. On the other hand, apart from the evidence from elsewhere in Africa, there is any amount of this species west of the Mchinga Escarpment, and therefore between these areas and those where *G. palpalis* occurs. We should, therefore, expect cases to have occurred between the Mchingas and Kasama before the present ones between Fort Jameson and the Mchingas. It is true, however, that the climatic conditions west of the Mchinga Escarpment are very different.

The situation with regard to *G. fusca* is still more perplexing. It is true that it occurs in the neighbourhood of Hargreaves, but it has not been found on the Nyamadzi nor to the north of Fort Jameson, an extremely waterless area which would seem most unsuitable to it. On the other hand, we know it to be locally not uncommon on the west shore of Lake Nyasa, from whence fresh cases are recently reported. Nevertheless near Karonga, where, as Dr. Sanderson informs me, *G. fusca* is common, no cases of Sleeping Sickness have been discovered, in spite of the fact that there is, or has been, direct connection between this place and the shores of Lake Tanganyika.

It has already been shown how scarce this insect is in the neighbourhood of Hargreaves, and that there is evidence that it is, at least, not abundant at other times of year. It becomes therefore extremely difficult to comprehend how it has become the cause of so many infections; and there are almost certainly more to be discovered. There is no evidence that this species enters native villages, rather the contrary. The only time that the local native would be likely to be bitten would be when he is bathing or drawing water. This he usually does during the day and not at dusk, when the fly appears to be most active.

This being the case, it becomes even more incomprehensible that the fly should have become infected, even were it certainly able to carry the parasite: especially as there is no evidence that anything but a very small number of natives from *palpalis* areas could ever have travelled over these roads. If the infection is a mechanical one, the organism effecting this must necessarily be numerous and in the habit of frequently biting human beings. The only other biting flies, excluding mosquitos, which, at the time of my visit, at all answered to this description were three species of *Tabanus*, viz.:—

T. tæniola and its varieties, a species allied to *T. ditæniatus*, and the species

recorded above as near *T. rothschildi*. These all frequented in considerable numbers the water-holes at native villages and frequently bit the natives, the last-named being apparently much the most bloodthirsty.

Amongst the biting organisms in native huts, on the other hand, Clinocoridæ and floor-maggots, but not *O. moubata*, are practically ubiquitous. On the whole, the balance of evidence, in the present state of our knowledge, would seem to be slightly in favour of one of these being the carriers of the disease.

The remarkable virulence and rapid course run by the disease in the Luangwa Valley cases is also worthy of note. Of the three Nyamadzi cases two are already dead, while of the seven Petauke ones three are dead and two more were in the last stage when I visited them some ten days ago; and this in spite of the fact that most of them denied feeling ill at all last April. The same is to be said, I understand, of many of the Nyasaland cases. It would appear, therefore, that we have here to face a particularly virulent strain of the disease, perhaps connected with the method of infection: or there is the possibility that a distinct Trypanosome, with an entirely new carrier, is the cause of these cases *.

There can be no doubt that there is most urgent need of a properly equipped Commission to make the necessary experiments and settle this point, not only in Rhodesia, but also in Nyasaland, where the problem appears to be identical. At present, the nature of the danger being uncertain, the authorities are practically helpless to combat it.

In conclusion I have to express my deep indebtedness to His Honour, the Acting Administrator of North-Eastern Rhodesia, and the officials generally of the British South Africa Company, who have rendered me every possible assistance.

Fort Jameson,
North-Eastern Rhodesia,
October 3rd, 1910.

[With regard to the distribution of *Glossina morsitans* shown on the accompanying map, it should be remembered that this includes only Mr. Neave's observations on his recent journey. Kinghorn and Montgomery make the general statement that it would be difficult to find a continuous area of fifty square miles free from fly anywhere in North-Eastern Rhodesia, except in the following localities:—the Serenji plateau, the neighbourhood of Fort Jameson, and on the high plateau between Lakes Nyasa and Tanganyika.

* [It is possible that the disease may be due to *Trypanosoma rhodesiense*, which has recently been described by Stephens and Fantham (Proc. Royal Soc. 1910, B. 561, pp. 28–32) from the blood of a European who had been in the Luangwa Valley.—Ed.]

NORTH-EAST RHODESIA

Route followed by Mr. S.A. Neave

Localities where sleeping sickness was observed

Scale 2,000,000 or 1 inch to 32 Miles

Miles 10 5 0 10 20 30 40 50 60 70 80 90 100

REFERENCE

International Boundaries

Provincial "

District "

Telegraph Lines

" " along roads

Telegraph Office T

Roads

Note

The Anglo-German Boundary from Lake Tanganyika to Lake Nyasa is taken from the Surveys executed in 1898 by the Joint Commission. In British Central Africa the districts North Nyasa & Central Angoni Land are from Surveys supplied by the Chief Surveyor, British Central Africa. No other portion of the country shewn in this map has been accurately surveyed, and the positions of the towns, etc can only be considered as approximately correct.

GERMAN EAST AFRICA

PORTUGUESE EAST AFRICA

CONGO FREE STATE

NORTH NYASA

CENTRAL ANGONI LAND

WEST NYASA

MARIMBA

LOANGWA

KASAMA

TANGANYIKA

MWERU

WEMBA

Wakisinga

Bemba

Lungu

Aushi

Swamps

Plateau

Lake Mweru

Lake Bangweulu

Lake Tanganyika

Lake Nyasa

Luangwa R.

Zambesi R.

Shire R.

Stanley Falls

Kazembe

Kampanda

Johnston Falls

Old Fort Rosebery

Fort Rosebery

Abercorn

Bismarckburg

Kasakalawe

Mikombu Sta.

Nyala

Fipe

Karonga

Kaiser C.

Sumtu

Kala

Aiungu

Kalonga

Chiwala

Tilanda

Ransanshi

Iboreka

Kapopo

Malambeka

Chepopo

Kalasa

Mkushi Riv. Sta.

Sakusira

Mwomboshi Sta.

Liteta

Algoa

Chiawa Sta.

Petauke

N.C. Charterland Store

Fort Jameson

Ft. Manning

Ft. Elwes

Serenje

Sanda's

Kawimbe

Mpika Sta.

Nsalia Sta.

Muchinga Mountains

Fort Alston

Kota Kota

Domira Bay

Fort Maguire

Fort Rifu

Dedza Boma

Mlanje Mt.

Zomba

Blantyre

Chiromo

Port Herald

Chinde

Quaqua

Chimwala

Mwanza

Kabwa

Kanoko

Kasiwa

Mwenzo

Mwenzo Mission

Kasanka

Kalungu

Kasinka

Kambwimbwi

Kasama

Mkawali

Mkowe

Moabe

Mrongo

Nyala

Karonga

Kaiser C.

We shall be glad to receive any *exact* information as to areas in which *G. morsitans* does or does not occur, accompanied, if possible, by a map.

The localities for *G. fusca* shown on Mr. Neave's map are the only ones at present recorded for North-Eastern Rhodesia.

Within this territory *G. palpalis* occurs along the shore of Lake Mwern and up the Kalungwisi River, and again along the southern shore of Lake Tanganyika and for some distance up the Lovu River; it has also been found for a considerable distance along the Luapula River.—Ed.]

INVESTIGATION INTO THE HABITS AND DISTRIBUTION OF TSETSE FLIES.

The thanks of the Entomological Research Committee are due to the following gentlemen who have kindly forwarded information on the above subject, in response to the circulars issued by the Committee :—

Dr. Thos. B. Adam, Medical Officer, Central Province, Southern Nigeria.
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Mr. E. Dayrell, District Commissioner, Ikom, Southern Nigeria.
Mr. R. E. Drake-Brockman, Medical Officer, Somaliland.
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Mr. H. Fell, Commissioner, Western Province, Ashanti.
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Mr. G. F. Hodgson, Asst. District Commissioner, Abak, Southern Nigeria.
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Mr. D. E. Price, District Commissioner, Oban, Southern Nigeria.
Mr. F. C. Selous, Worplesdon, Surrey.
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